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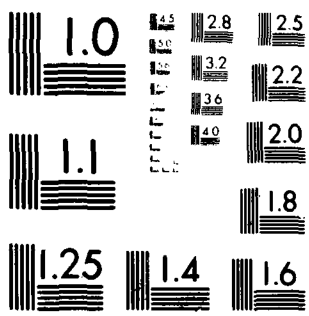

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FINAL REPORT

DESCRIPTION AND ANALYSIS OF TRENDS IN CONUS COMMON CARRIER OFFERINGS

June 1980
(revised November 1980)

Prepared for
DEFENSE COMMUNICATIONS AGENCY
DEFENSE COMMUNICATIONS ENGINEERING CENTER
1860 WIEHLE AVENUE
RESTON, VIRGINIA 22090
under Contract DCA100-79-C-0039

ARINC RESEARCH CORPORATION

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This study describes and analyzes trends in CONUS common carrier offerings. It identifies and quantifies factors affecting the cost of future offerings and provides a methodology to update the forecasts as economic scenarios change. Specific offerings considered include those of AT&E, MCI, SPCC, WUI, and RCA. Both terrestrial and satellite communications are included in the analysis.

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Prepared for

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1860 Wiehle Avenue
Reston, Virginia 22090

under Contract DCA100-79-C-0039

by

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FOREWORD

Under Contract DCA100-79-C-0039 with the Defense Communications Agency, Defense Communications Engineering Center, ARINC Research Corporation identified, described, and analyzed trends in CONUS common carrier offerings over the 15-year period 1980 to 1994.

This study provides a method by which DCA can develop trends of service costs for major services provided by AT&T, Southern Pacific Communications Corporation (SPCC), Microwave Communications, Inc. (MCI), RCA Americom, and Western Union. These trends are developed through the use of an automated forecasting tool -- the Commercial Telecommunications Cost Prediction and Assessment Model (CTC-PAM). This model and the associated service data base of costs and statistics were developed to assist the DCA in its architecture and planning of the advanced phases of the DCS.

The successful completion of this work required high levels of technical effort by the project team and our economic consultants, Snavely, King, Harris and Associates. Particular thanks are extended to the Contracting Officer's Technical Representative, Mr. W. Hartung, of the Defense Communications Agency, Defense Communications Engineering Center, for his guidance and assistance.

We are grateful, finally, for the unusually fine cooperation we received from MCI, RCA, SPCC, and WU, and the considerable support provided by AT&T.

ABSTRACT

This report summarizes a study designed to describe and analyze trends in United States domestic common carrier offerings over the 15-year period 1980 to 1994. The work was conducted for the Defense Communications Agency, Defense Communications Engineering Center, Reston, Virginia, by ARINC Research Corporation, Annapolis, Maryland. A commercial telecommunications cost prediction and assessment model and a cost data base were developed to conduct trend analyses given changing scenarios of various inflation rates, technology infusion rates, and other cost-related factors.

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CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

1.1 STUDY BACKGROUND

The Defense Communications Agency (DCA) is responsible for the management, operations, planning, and systems engineering of the Defense Communications System (DCS). In this role, DCA continuously conducts studies, makes plans, and initiates improvements to the DCS in order to meet requirements of the Department of Defense (DoD) for a reliable and cost-effective telecommunications system. The DCS is a diverse global communications system comprising a combination of leased and U.S. Government-owned facilities. The continental United States (CONUS) DCS portion primarily comprises leased facilities and services furnished by the American Telephone and Telegraph Company, its 23 operating subsidiaries or telephone companies, and about 1,600 independent telephone companies. This industry is regulated at both the state and national levels, accounts for more than $100 billion of in-plant investment, and provides the largest and most effective telephone service in the world.

It is expected that the CONUS DCS will continue to procure services by leasing them in future years; however, significant trends and forces (e.g., the impact of technology, regulation, competition, and the free-enterprise system) have produced a dynamic and growing variety of interstate alternatives for the CONUS DCS transmission and switching services and facilities. The overriding considerations in exploring alternatives to the present DCS configuration are the economic savings and rate stability that may be realized by Government ownership or lease of facilities (such as earth terminals or circuit switches) or through optimum combinations of AT&T and specialized carrier offerings.

Since the DCS is being upgraded and reoriented to meet present and future command, control, and communications (C^3) requirements, DCA will need a description and analysis of trends in CONUS common carrier offerings over a period of time extending into the early 1990s. Such a study would allow DCA to use the developed trends (which would include sensitivity of rates to factors such as regulation, inflation, rate of technical change, corporate carrier policies and plans, and market effects) in its engineering and architecture efforts associated with the evolving DCS. In addition, documentation of methods of developing these trends would enable DCA to

investigate new trends (as required by changes in factors affecting the DCS) in its development of cost-effective DCS alternative plans.

To address the need for a description and analysis of trends in CONUS common carrier offerings, the Defense Communications Engineering Center (DCEC) of DCA contracted with ARINC Research Corporation. This report presents the results of the ARINC Research work performed for DCA under Contract DCA 100-79-C-0039 from 19 July 1979 to 11 July 1980.

1.2 STUDY OBJECTIVES

The overall objective of this project is the development of a methodology to enable CONUS DCS planning in light of the many uncertainties in future common carrier offerings and rates. Specific objectives are as follows:

- To establish a data base of carrier costs for each of several relevant carrier service categories
- To describe the current tariffs and plans for each of the relevant carriers
- To identify, describe, and quantify the major factors affecting future services and costs for each of the relevant carrier service categories
- To project the form and rate bounds of future tariffs for each of the relevant carrier service categories
- To document the methodology of analyzing tariff trends and recommend a procedure to enable periodic revision of the analysis of service trends

Meeting these objectives will provide DCA with a means of analyzing the factors affecting the cost of services associated with interstate tariffs.

1.3 DESCRIPTION OF TASKS

The tasks performed to meet the objectives stated in Section 1.2 are described by the following task statements, which incorporate the major requirements of the contract statement of work.

1.3.1 Task 1: Analyze CONUS Common Carrier Trends

In Task 1 we identified and described trends in CONUS common carrier offerings, using various service filings, annual cost studies, and related data bases of interstate facilities. This analysis was designed to ascertain trends in the following segments of communications services:

- Terrestrial transmission services
- Satellite transmission services

- Access and tandem switching
- Satellite earth terminals
- Satellite space segment

In the analysis, we considered the following common carriers and equipment manufacturers:

- AT&T (interstate only)
- Western Union
- Two satellite carriers such as American Satellite Corporation (AMSAT), Satellite Business Systems (SBS), and RCA
- Two specialized terrestrial carriers such as Southern Pacific Communications Company (SPCC) and Microwave Communications, Inc. (MCI)
- Equipment manufacturers: Harris, ROLM, and Northern Telecom

An initial activity of this task was to select two specialized terrestrial common carriers (SCCs) and two satellite common carriers. We reviewed filings and audits available for the satellite and terrestrial carriers to determine which carriers had the most complete financial and operating data.

Seven subtasks were accomplished during Task 1:

- Define services to be studied
- Determine data requirements
- Determine data sources
- Gather data
- Refine data and establish data base
- Analyze data and document trends
- Develop and document software to project cost of services

Most of the project data acquisition, refinement, and analysis was accomplished in this task. Software was developed in a later task so that the cost of services might be econometrically extrapolated into the future, given a baseline economic scenario of trends in various cost-driving factors (e.g., inflation effects of labor, inflation in equipment costs, and effects of infusion of technology). This software was designed to accept scenarios of driving factors developed and assessed in Tasks 2 and 3.

1.3.2 Task 2: Describe Factors Affecting Future Service Offerings

In Task 2 we identified and described factors likely to influence trends in cost and carrier service rates or lead to new service offerings.

In the conduct of this task we systematically researched and evaluated major factors in terms of their potential effects on service trends. These factors included Federal Communications Commission (FCC) docket issues, congressional actions, competitive forces, technology, and inflation.

Four subtasks were accomplished during this task:

- Review literature and document factors and potential effects
- Discuss certain actions, forces, and services with appropriate agencies and firms to assess factors and trends
- Develop trend matrix relating factors to current or proposed services
- Assess extent of each factor's benefit or detriment to the DCS

We used the factor assessment in the next task to prepare scenarios for assessing the collective impact of factors on cost of service.

1.3.3 Task 3: Assess Collective Impact of Identified Factors

In Task 3 we developed the following scenarios to provide the basis for assessing the collective impact of the factors identified in Task 2:

- A worst-case situation, in which factors combine to cause a significant increase in rates. As an example, the FCC may grant an increased rate of return to AT&T, which, combined with excessive inflation over a long time, may result in large rate increases.
- A best-case situation, in which factors combine to cause a minimum impact on future rates. As an example, inflation may have minimal impact on a modern service -- for example, AT&T's enhanced private switched communications service (EPSCS) and Southern Pacific Communications Company's (SPCC's) SPRINT services -- because of technical efficiencies that reduce the effects of inflation on labor. This technological improvement -- combined with the more efficient use of transmission facilities on a shared-use basis and a regulatory hands-off attitude as regards specialized common carrier (SCC) pricing and rates of return -- could tend to stabilize service rates over many years.

Seven subtasks were necessary to accomplish the objectives of this task:

- Develop and document possible scenarios for major issues, factors, and trends
- Develop software that will model service trends, including scenarios that take influencing factors into account
- Establish and document estimation errors and confidence-interval bounds on trends
- Assess likelihood and timing of emerging services
- Establish rate bounds and tariff forms for emerging services

- Exercise computer model to develop trends in services with each major scenario
- Document trend details for specific categories of services and equipments

1.3.4 Task 4: Develop Procedures to Update Trends

Having developed trends and the impacts of factors on service rates, we developed procedures with which DCA may update trends in services and equipments as costs and factor changes are hypothesized to occur. Four subtasks were necessary to accomplish the objectives of this task:

- Document trend analysis methods and algorithms employed in the study
- Document data sources
- Document refined data base
- Document computer programs to be used in investigating trends and bounds

Two types of documentation were produced in this task. The first provides software documentation of computer models and includes an overview, program description, flow diagrams, and coding. The second type of documentation provides a user manual that will allow a systems analyst to replicate studies by following the directions in the manual and will allow a user to trace through an actual problem, which will represent a category of the services studied.

1.3.5 Task 5: Prepare Final Report and Briefing

When all aspects of the previous work activities were documented, a final report was drafted, coordinated with DCA for comments, put into final form, and delivered, with a formal briefing.

The following subtasks were necessary for completion of this task:

- Develop and coordinate outline
- Write draft final report and prepare briefing
- Coordinate final report with DCA
- Include DCA comments in final report
- Deliver final report and briefing

1.4 COORDINATION, DATA ACQUISITION, AND FIELD SURVEYS

To assemble the information base of this study required extensive research, comprising the acquisition of FCC and corporation records and

surveys of agencies and companies. A schedule of data research and acquisition activities was designed so that the data would be available for use when required in specific subtasks.

All data collected were documented as to their source and nature, with appropriate comments on their contents, quality, and use. The raw data base developed in this fashion comprises about 4,500 pages of information principally filed with the FCC and is concerned with tariffs and docket proceedings.

1.5 REPORT ORGANIZATION

This report is not organized in accordance with the sequence of tasks described in Section 1.3.5. Our preliminary assessment of the project work flow was as described; but when the project was under way, it became evident that the work flow had to be modified. Although each task discussed in Section 1.3.5 was performed, certain elements of each task were addressed at different times. The following overview of the chapters will highlight their relation to the tasks delineated in the contract statement of work:

- Chapter Two describes the rationale for the selection of other common carriers (OCCs) for study and gives the regulatory background of the carriers, their financial characteristics, and the services they provide. This chapter provides the background necessary for performance of all the project tasks.
- Chapter Three describes the characteristics of carrier network operations and cost structure. It describes the facilities and technologies required to provide services; the contemporary marketplace; the effects of competition and inflation; regulatory, legislative, and business policy issues; and the rationale for the selection of the methodology we used to forecast cost trends. This chapter provides data for the analysis of the tariff trends (Task 1) and for the description of factors affecting future offerings (Task 2).
- Chapter Four describes the factors that have substantial impact on the commercial interstate carriers and their specific potential effects on cost of service, rate structure, and service tariffs. Next, scenarios are described that may be used by the methodology for service-cost trend forecasting developed in this study and summarized in Chapter Three. This chapter is related directly to the description of factors affecting future offerings (Task 2).
- Chapter Five summarizes the commercial telecommunications cost and prediction assessment model (CTC-PAM) in terms of the data base it employs, its architecture, the data supplied by the user, the algorithms contained in model outputs, and examples of use of the model to acquaint the reader with the forecasting techniques and algorithms employed in this study. This chapter is related to the assessment of factor impact (Task 3) and the procedure for updating the common carrier trends (Task 4).

- Chapter Six describes the general methodology and the results of carrier service-cost forecasts for major interstate services utilizing worst-case, best-case, and expected-case factor scenarios. Also discussed are specialized forecasts concerning such issues as local distribution, leased PBXs, tandem switching arrangements, and satellite terminals. In addition, this chapter presents significant conclusions based on our findings in our analysis of service trends. This chapter and the following chapter are related directly to the trend analysis efforts of Task 1.
- Chapter Seven summarizes the cost trends of current carrier offerings and also discusses emerging services. The beneficial effects of competition and issues that the DCA should be considering in procuring CONUS services are also presented. The chapter closes with a discussion of areas requiring further study, a summary of significant findings, and the major conclusions drawn from the cost trend analyses.

CHAPTER TWO

DESCRIPTION OF CARRIERS

In Chapter One we set forth (1) the need for the DCA to understand and project interstate carrier service costs and rates, (2) the project objectives, (3) the technical approach and tasks designed to accomplish the objectives of the study, and (4) the organization of this report.

In this chapter we develop a generic portrayal of the structure of the U.S. domestic commercial telecommunications industry, in order to establish a background perception of the corporations providing domestic interstate services. In addition, we discuss the regulatory background, the market structure of services offered, the effects of competition, and the rationale for the selection of two terrestrial and two satellite carriers for study in this project.

2.1 CURRENT INDUSTRY STRUCTURE AND REGULATORY BACKGROUND

It is imperative to recognize that the industry structure, in its present form, represents a dynamic equilibrium of the following major forces:

- Regulation
- Technology
- The American free-enterprise system
- A prestigious and successful American telecommunications monopoly

The current industry structure is best described as one that has evolved from the service and operation base of a highly successful American monopoly. This monopoly base possesses three major components, which include several large corporate entities and a substantial number of smaller corporations, as follows:

- American Telephone and Telegraph (AT&T) and its 23 operating companies and Bell Laboratories, which are known collectively as the Bell System
- Approximately 1,600 independent telephone companies (e.g., the General Telephone System, the United Telecommunications System, the Continental Telephone companies, and the Rochester Telephone Corporation)

- Western Union Telegraph Company (WU), which is the oldest element of the telecommunications industry and until recently was the sole provider of message telegraph services (telegrams, telegraphic money orders, and mailgrams)

Competition in the provision of telecommunications services and facilities was initially allowed and has been fostered by a steadily growing number of U.S. Supreme Court and Federal Communications Commission (FCC) decisions over the past two decades. The interstate segment of the domestic telecommunications marketplace was initially opened to competitive entry when the FCC initiated Docket 11886 in 1956, known as the "Above 890" proceeding. This proceeding concluded in 1959, when the FCC decided to make frequencies available to private microwave systems for business use. In its ruling the FCC found that nothing in the record suggested that adverse economic effects would result from the licensing of private systems.

Several other cornerstone federal court and FCC decisions further opened up the domestic telecommunications marketplace. In 1956 the U.S. Court of Appeals for the District of Columbia ruled that AT&T tariff restrictions against interconnection of customer-supplied terminal equipment were an unwarranted interference with the telephone subscriber's right to use his telephone in ways that are privately beneficial without being publicly detrimental. This case is often cited as the "Hush-a-Phone" decision, after the name of the device that had been prohibited by AT&T's tariff.

In 1968, invoking the principle developed in the *Hush-a-Phone* case, the FCC held unlawful a broad AT&T tariff prohibiting the Carterphone (an induction/acoustically coupled device that allowed a mobile telephone user to access the public telephone network through the mobile radio's base station). Almost concurrently, growth of the computer and private-line services and a recognized need for more appropriate private-line facilities prompted the FCC to begin the Computer Inquiry in 1966. The FCC felt that revelations arising in the Above 890 case indicated a need for new and more flexible private-line services that would best be implemented with facilities designed for private-line use rather than exchange-telephone use.

In 1970 the FCC, upon reviewing a large number of applications for microwave stations by Microwave Communications, Inc. (MCI), Data Transmission Company (DATRAN), and others, initiated Docket 18920 (specialized common carriers). A decision in 1971 that has become known as the "Specialized Common Carrier Decision" granted MCI its Chicago-to-St. Louis system. Beneficial effects cited by the commission included broadened consumer choices, dispersed responsibility for the supply of communications, economies of specialization, provision of a regulatory yardstick, and an incentive for technical and service innovation for the giant AT&T monopoly. In 1972 the DOMSAT decision, resulting from FCC Docket 16495, which had set forth policies for the authorization of domestic satellite facilities, established a policy of multiple entry by telephone and specialized carriers into the prospective satellite marketplace.

These regulatory and court decisions led to a significant fragmentation of the regulated noncompetitive domestic telecommunications marketplace into a competitive marketplace that allows free entry of firms that wish to provide interstate telecommunications services. The commitment of the FCC to maintain the benefits of a competitive marketplace was further promulgated by the FCC's "Resale and Shared Use" decision and other decisions that further broadened competition by allowing brokerage and value-added communications services to be provided with a minimum of capital investment. It is apparent from these activities that the present segmentation of the marketplace was prompted by a desire to induce competition, provide a means of taking advantage of emerging technologies, and expand services and other benefits to the consumer. These actions, in turn, shaped the domestic telecommunications industry in the structure we know today.

In addition to Bell and Western Union, the common carriers are of the following four basic types:

- The specialized common carriers (SCCs)
- The domestic satellite carriers (DOMSATs)
- Resale (including value-added) carriers
- The miscellaneous common carriers (MCCs) or video common carriers

These carriers are described chiefly on the basis of their methods of transmission because their service types often overlap and are competitive with one another and with established carriers without regard to their prime mode of transmission. After discussing the carriers by prime mode of transmission, we shall discuss the various services offered. This discussion is preliminary to the selection of two specialized terrestrial and two specialized satellite carriers for study because the services offered, the extent of available data, and other factors are important in the selection process.

2.2 MARKET STRUCTURE OF INTERSTATE CARRIER INDUSTRY

Any discussion of the domestic telecommunications industry must begin with the industry's giant entity, AT&T. AT&T has assets (as of 1978) totaling $103.3 billion and revenues in excess of $41.0 billion. AT&T and its operating companies, in conjunction with the independent telephone companies, provide local and toll telephone service including interstate message telecommunications service (MTS) and wide area telecommunications service (WATS). It is also the largest provider of private-line services, including point-to-point data transmission and transmission of television broadcast programming. It is ubiquitous: it provides alternative service for virtually every offering made by the specialized common carriers (SCCs) and provides the bulk of local distribution facilities required by the SCCs in the delivery of their services. It is paradoxical that the SCCs that compete with AT&T must rely on AT&T for interconnection with their subscribers' premises. AT&T's obligation to provide such interconnection has been clearly established, but the rates and terms of service provisions for these facilities are frequently in dispute.

The only established carrier providing domestic telegraph communications services is Western Union International (WU), which until recently was the only provider of public message telegram service. WU also offers various private-line and video-relay services in competition with the SCCs and AT&T, by means of its Westar satellite and terrestrial microwave systems. Western Union's 1979 gross assets totaled $1.7 billion and its revenues totaled about $636 million.

2.3 SPECIALIZED COMMON CARRIERS

The specialized common carriers (SCCs) provide terrestrial point-to-point voice and data communications, primarily by means of their own microwave-transmission facilities. The SCCs initially offered private-line services; recently most of them have expanded their offerings to include switched services and some services equivalent to MTS and WATS. In 1969 MCI became the first nontelephone company to provide common carriage by microwave transmission. This service was established between Chicago and St. Louis. MCI has since established coast-to-coast service. In addition to MCI, SCCs include Southern Pacific Communications Company (SPCC), United States Transmission Systems, Inc. (USTS), Western Telecommunications, Inc., and CPI (owned by WU), which provides service on a regional basis.

In this study the corporations providing specialized carrier services on a regional basis (Western Telecommunications, Inc., and CPI) will not be discussed at length because their services would be applicable to the DCS in only a limited way.

The last three carriers listed in Table 2-1 (Telenet, Tymnet, and Graphnet) are known as value-added network (VAN) carriers and are not included in the scope of this study. The VANs lease transmission services from carriers and install switching computers and other processing equipment at appropriate city nodes to form specialized networks. These networks are designed to transport digital information (by a packet-switched network) with VAN-managed error rate, speed and protocol conversion, information storage and retrieval, and miscellaneous message-type services. The FCC has licensed the three VANs listed. Telenet has been in operation since 1973, Tymnet since 1976, and Graphnet since 1975. The service offerings provided by these carriers are significant in terms of function and potential use.

2.4 SERVICE STRUCTURE

Table 2-1 lists the interstate services currently offered by AT&T, Western Union, and the OCCs. Two generic types of services are in demand in the interstate marketplace:

- Basic private-line service
- Complete end-to-end service

Table 2-1. CURRENT INTERSTATE TARIFFED OFFERINGS		
Carrier	Type of Carrier	Current Service Offerings
AT&T	Terrestrial	MTS/WATS Series 2000 (Voice) Series 3000 (Data) Series 7000 (Video) Series 8000 (Voice and Data 56 Kbps) Picturephone Meeting Service Digital Data Service (DDS) Common Control Switching Arrangement (CCSA) EPSCS Electronic Tandem Switching (ETS) Centrex Advanced Communications Service (ACS)*
WU	Terrestrial and Satellite	Multipoint Data Service Hot Line Space Tel Mailgram TELEX/TWX Private Line • Voice • Data Broadband Transponders SDX-Type Service* EXECUNET-Type Service*
American Satellite Corporation (ASC)	Satellite	SDX Foreign Exchange (FX) Circuits CCSA • Trunk Circuits • Access Lines Data • 2,800 - 9,100 bps • 50 Kbps - 1.5 Mbps Shared Business Telephone Service
MCI	Terrestrial	EXECUNET Quickline Network Service Shared Private Line CCSA Faxnet Private Line • Voice • Data

(continued)

Table 2-1. (continued)		
Carrier	Type of Carrier	Current Service Offerings
SPCC	Terrestrial and Satellite	SPRINT Satellite Transmission Service Data Dial Dedicated Switch Service Scheduled Metered Private Line Private Line • Voice • Data
RCA	Satellite	Private Line • Voice • Data • 56 Kbps - Plus Service Broadband Transponders
ITT (USTS)	Terrestrial	Private Line • Voice • Data SPNS CCSA City Call Data Transmission Service
Telenet	VAN* Carrier	Packet-Switched Data Service
Tymnet	VAN* Carrier	Data Transmission Service ON-TYME
Graphnet	VAN* Carrier	Facsimile Service

*Value-added network.

The first service allows the customer to attach his owned or leased end terminal equipment to basic transmission channels provided by the carrier. In the second service the carrier provides service by aggregating elemental processing and other terminal equipment components into a single end-to-end specialized service offering. In essence, a user may procure a transmission path (which he may use for a simple voice connection or for transmission facilities between sophisticated end equipment such as an assemblage of computers, multiplexers, and modems), or the user may choose to lease an end-to-end service such as the AT&T digital data service (DDS), which allows direct intercity communications between data processing centers.

2.5 MARKET SHARING

The market shared by the various types of carriers is completely dominated by AT&T: its 1977 interstate revenues were $11.1 billion, whereas all other carriers exclusive of WU had revenues of only $120 million, far less than 1 percent of AT&T's revenues, although the current OCC share is somewhat larger than the 1977 statistics indicate. In addition, part of the market (the local distribution facilities that connect a customer's premise to wire centers) cannot be efficiently supplied by the OCCs; thus most OCCs that compete in the marketplace rely on AT&T for interconnection of their facilities with the customer's premises. Thus there are segments of the marketplace that are critical to intercity competition and fully under the market control of the dominant carrier, AT&T.

Recent OCC success in the telecommunications marketplace has been obtained by the following means:

- Aggressive and resourceful marketing, fine-tuned to customer needs
- Ability to price AT&T-equivalent services advantageously below AT&T's prices by use of current technology
- Ability to configure new services in order to meet user-perceived requirements
- Success in providing price differentiation
- Use of innovative technology to provide new types of service
- Aggressive management that seeks to make effective use of scarce investment and human resources
- Inclination to further their competitive position aggressively through regulatory and judicial methods
- Capitalization on FCC efforts to regulate AT&T through competition

2.6 SELECTION OF CARRIERS FOR STUDY

In accordance with the project plan, we researched and evaluated specialized common carriers and satellite carriers to determine the extent

of data available in order to select for study two carriers in each category, in addition to Bell and Western Union. The relevant characteristics of firms considered for study are summarized in Table 2-2. It should be noted that the primary criterion for selection of carriers was the extent of data availability, since the OCCs are not required to file extensive financial and operating reports with the FCC.

As shown in Table 2-2, three principal specialized carriers have been providing service for several years: MCI, SPCC, and USTS. MCI and SPCC were the largest suppliers of services (in 1978) in terms of gross operating revenues and have been in business the longest, and data and relevant filings for these firms were more plentiful than for USTS. For these reasons we selected MCI and SPCC as the terrestrial SCCs to be studied.

Four operating satellite common carriers are listed in Table 2-2: American Satellite Corporation (ASC), Western Union International (WUI), RCA, and Satellite Business Systems (SBS). AT&T and General Telephone and Electronics together formed the AT&T/GTE Satellite Corporation COMSTAR, a domestic satellite operation that is not regarded as a competing service because of its telephone industry affiliation and was therefore not considered a candidate for the study.

We found that there was a limited quantity of data regarding Western Union and RCA, since these satellite services required numerous filings with regulatory commissions in which satellite operations must be separated. American Satellite is owned by an unregulated company and is mainly a broker of channels leased from other satellite carrier facilities. Satellite Business Systems is considered a potentially strong entry into satellite operations, but there is no definitive financial information on it available at this time. For these reasons, we selected Western Union and RCA for study.

Table 2-2. AVAILABILITY AND ASSESSMENT OF SPECIALIZED COMMON CARRIER DATA

Common Carrier	Type of Carrier	Data on File with FCC	Revenue Base: Services	Revenue Base: Year Ending 12/31/78	Revenue Base: Increase (Decrease) from Previous Year	Remarks
Microwave Communications, Inc. (MCI)	Terrestrial common carrier	1. Corporate annual report to the FCC 2. Initial application Docket No. 16509	1. Dedicated voice grade 2. Shared/switched voice grade 3. Other operating Total	\$33,824,721 39,867,076 4,444,223 \$78,136,020	\$ 2,378,238 8,521,313 1,571,874 \$12,471,425	Started providing service in 1972
Southern Pacific Communications Company (SPCC)	Terrestrial common carrier	1. Corporate annual report to the FCC 2. Initial application as a common carrier	1. Dedicated voice grade and dedicated data 2. Shared/switched voice grade 3. Shared/switched data 4. Other operating Total	\$35,370,395 11,869,644 1,653,971 1,027,247 \$49,921,257	\$ 4,350,698 11,443,905 1,533,068 618,347 \$17,946,018	Started providing service in 1973
United States Transmission Systems, Inc. (USTS)	Terrestrial common carrier	1. Corporate annual report to the FCC 2. ITT's initial application as a common carrier	Dedicated voice grade	\$ 8,872,570	\$ 5,361,659	Started providing service in 1976
American Satellite Corporation (ASC)	Satellite common carrier	1. Corporate annual report to the FCC 2. Initial application	Dedicated commercial	*	*	1. Started providing service in 1972 2. A subsidiary of Fairchild
Western Union Telegraph Company (WU)	Satellite common carrier	Service filings	1. Private-line voice and data 2. Record and voice service 3. Telegraph and mailgram services	*	*	Started providing service in 1974
RCA	Satellite common carrier	Service filings	1. Video and audio services 2. Private channels 3. Government communications services	*	*	Started providing service in 1975
Satellite Business Systems (SBS)	Satellite common carrier	No financial data	Proposed commercial services	See "Remarks" column, Note 1.	See "Remarks" column, Note 1.	1. A privately held partnership with no disclosed financial data 2. Established as a consortium of IBM, AETNA, and COMSAT

*The FCC annual reports do not break out revenue data for satellite common carriers.

CHAPTER THREE

CARRIER OPERATING AND COST STRUCTURE CHARACTERISTICS

In this chapter we will discuss the types of services to be studied, the facilities required for service provision, and the technologies available to provide these service facilities. We will also discuss the market structure of the services, the resulting competition, and the major inflation-related cost drivers.

3.1 SELECTION OF INTERSTATE SERVICES FOR STUDY

In reviewing the preliminary objectives of this project, we determined which generic categories of services would be described and analyzed in our studies. These categories were selected according to the following criteria:

- The categories should reflect the present and future telecommunications procurement interests of DCA.
- For analysis purposes the categories should be so defined that we might make maximum use of available historical data.
- The categories should reflect natural groupings of physically distinct facilities in order that we might accurately assess costs.

As stated earlier, interstate services are of two generic types: (1) basic private-line service and (2) complete end-to-end service. The first component simply provides a basic talk path between, say, two PBXs or key systems. The transmission line is, in this case, a private line connecting customer-owned or -leased termination equipment. The second component is a transmission path connecting a set of end terminal equipments, both supplied by the carrier. The end terminal equipment in both services provides a useful function; however, the terminal equipment in complete end-to-end service may provide such functions as the following:

- Transmission resource sharing. Both voice and data traffic share leased private-line facilities. The sharing function is accomplished by means of end terminal equipment, which may be an electronic PBX, digital multiplex, or equipment and line modems. These terminal devices provide line sharing for more efficient use of transmission facilities.

- Enhanced services. Basic transmission facilities and other terminal nodes or facilities (such as tandem switches, PBXs, and message switches) are interconnected to allow a network of nodes to be interconnected by transmission lines. Transmission resources are shared, as in the previous case; however, more sophisticated services offered by this network may include the following:

  - Switched voice services that allow a subscriber to place long distance calls from any telephone on a measured-use basis. This service (often called toll service) includes the dominant message telecommunications system (MTS) offering of AT&T. Switched-voice alternatives to toll usually require the customer to pay a flat monthly rate for an access line and to pay for calls on a metered-use basis. Typical of these services are AT&T's wide area telecommunications service (WATS), SPCCs SPRINT services, and MCI's EXECUNET. Switched-voice services may also include enhanced features such as least-cost call routing, code access, alternate routing, network management, and other user and network-related capabilities.

  - Switched-data services that allow packet switching and message switching to be performed for message delivery. Line sharing is utilized; however, multiple users, multiple protocols, and line speeds may be interfaced by the network by means of protocol and speed conversion functions provided at the central office or on the customer's promises.

  - New-generation distributed integrated business exchange (IBX) services. These services have the general architecture of distributed switching capability for local and tandem voice operation, the capability of handling synchronous or asynchronous data, four-wire digital transmission for data, and speed and protocol conversion. These services are generally suited to both large and small businesses, since they present an opportunity to reduce toll-call costs by substituting a similar service. The services may be utilized on a "stand alone" basis or may be interconnected with a large private-line-based Government or corporate network to provide access to a cheaper service than DDD (toll) when all private lines are busy.

In all the above-described enhanced services, the transmission facilities are provided by a common carrier. In the first case (switched voice), the service is usually an end-to-end service provided by a carrier. The last two services may have customer-owned or -leased equipments interconnected with carrier-provided transmission lines, or end-to-end services may be provided by the carrier.

Table 3-1 lists the basic transmission services to be studied. For example, AT&T services to be studied are the Series 2000 (voice) and Series 3000 (data) discrete analog and Series 5000 analog bulk Telpak transmission services. In the digital area, AT&T's Series 3000 and 8000 (DDS) low-,

Table 3-1. BASIC TRANSMISSION SERVICES TO BE STUDIED, BY CARRIER AND TYPE OF SERVICE

Company	Analog Services		Digital Services	
	Discrete	Bulk	Low, Medium, and High Speed	High Capacity
AT&T	Series 2000 and 3000 (MPL)	Series 5000 (Telpak)	Series 3000 and 8000 (DDS)	1.544 Mbps
WU (Terrestrial)	Series 2000 and 3000 (MPL)	Series 5000 (Telpak)	N/A	N/A
MCI	MCI #1 Point-to-Point	See Note 1	N/A	N/A
SPCC	SPCC #2 Private-Line Service	See Note 1	Data Dial 1	N/A
RCA (Satellite)	Point-to-Point	See Note 2	N/A	56 Kbps
WU (Satellite)	Point-to-Point	See Note 2	N/A	56 Kbps

Notes:
1. Equivalent bulk rates are obtained by price discounts in the tariff rate structure based on quantity of service leased.
2. Studies of broadband services are based on the aggregation of discrete point-to-point services.

medium-, and high-speed services will be studied, as well as the high-capacity 1.544 Mbps offering. This table distinguishes analog and digital services because the digital services are complete end-to-end circuits providing transmission facilities for data and the pure analog transmission offering (such as AT&T's Series 3000) is able to support data given the use of modems and multiplexers. Various AT&T facility costs and rates are also forecasted for such services and facilities as the following:

- Interstate foreign exchange service (FX)
- Local exchange service
- Terminals (e.g., telephone sets, key sets, and modems)
- Local distribution facilities
- Local and toll switching facilities

These services and facilities are used as elements of services provided by both AT&T and other common carriers.

MCI and SPCC (see Note 1 of Table 3-1) provide the equivalent of bulk services through their tariff-pricing methodology, which allows a price-per-mile discount based on total channel miles and number of channels or other dimensions of quantity under lease. The question of bulk transmission rates (e.g., purchase of 60 or 240 AT&T Telpak voice-grade circuits between two cities) versus quantity discounting (e.g., purchase of SPCC's private-line service based on total circuit miles leased) will be discussed later. In particular, economic and technical reasons for being able to justify discounting will be analyzed and several likely tariff forms postulated.

In addition to basic transmission services, certain terminal equipments will also be studied. These include PBX Class 5 (line-switching node facilities), Class 4 (tandem-switching node facilities), and satellite earth terminals. These devices were sample-surveyed and representative costs were used to synthesize services and project the cost of services for node access through these types of terminal (and network) equipment.

Having described the basic private-line services and certain terminal equipments to be studied, we will now describe the complete end-to-end services to be studied. Table 3-2 lists these enhanced interstate service offerings. Both network switching and measured-use services are end-to-end services requiring terminals to be placed on the customer's premises and most network or service sophistication to be provided by the carrier. For example, an outward WATS line may be leased from AT&T and may be terminated in a leased Bell PBX. The CCSA and EPSCS offerings provided by AT&T are more sophisticated services that allow node access and internode switching of subscriber traffic. In addition, the subscriber may establish a network management facility to aid in providing quality control and adjustment of network access lines and internode trunks.

Table 3-2. ENHANCED INTERSTATE SERVICE OFFERINGS BY CARRIER AND TYPE OF SERVICE		
Company	Offerings to be Studied	
	Switching	Measured Use
AT&T	CCSA EPSCS	WATS Interstate MTS
WU (Terrestrial)	N/A	Hot Line
MCI	CCSA	EXECUNET
SPCC	N/A	SPRINT

3.2 FACILITIES REQUIRED FOR SERVICES

Figure 3-1 provides a schematic diagram of the general types of facilities used in the provision of domestic telecommunications services in CONUS. It should be noted that the major portion of the nation's telecommunications network is provided by Bell. The other common carriers (e.g., MCI, SPCC) provide principally long-haul intercity services, but these services require substantial use of Bell end facilities such as central offices and local distribution.

Perhaps the best explanation of the workings of the generic network given in Figure 3-1 may be given by tracing the path of both a local call (intraexchange call) and a toll call. For the local call, if a subscriber at Terminal A in Washington, D.C., wishes to call a subscriber at Terminal B in Washington, D.C., he dials the local office number 342 and the four digits assigned to Subscriber B. His call first traverses a local distribution facility made up of aerial and underground cable (from his home to the 342 local central office); next the call is switched in the local switching office to the line or connector group associated with Subscriber B, and the call is completed when B answers. The local central office may consist of step-by-step, crossbar, electronic, or digital switching technologies. Within the local office there are interoffice carrier equipment terminals, cable termination and cross-connection frames, power back-up lead acid batteries, test panels and equipment, and other facilities required to provide local services. Two major types of trunks provided are of central concern in this study:

- Interexchange trunks
- Intertoll grade trunks (line haul)

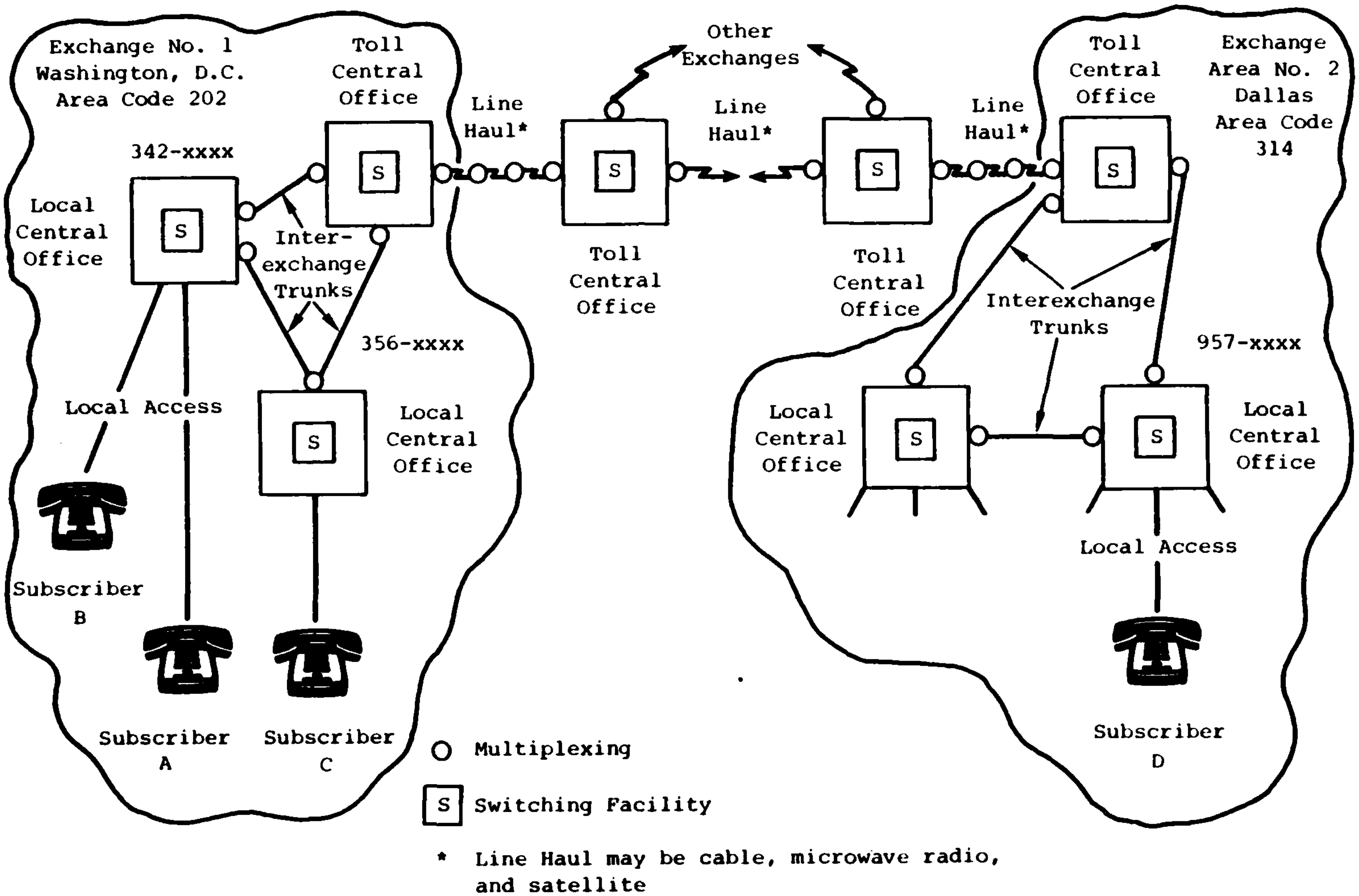


Figure 3-1. SCHEMATIC DIAGRAM OF THE DOMESTIC TELEPHONE SYSTEM

The interexchange trunk provides connections from, say, Subscriber A to Subscriber C in the 356 exchange in Washington D.C. The intertoll grade trunks connect toll central offices. The main differentiating factor is that the interexchange trunk is not used for toll calls and generally comprises voice-conditioned cable pairs and, in certain instances, interexchange carrier equipment that allows 24 or more conversions to be conducted simultaneously over two pairs of wires.

If Subscriber A places a toll call to Subscriber D in Dallas, all the facilities described in the above local call example are used, with the exception that a toll central office is used to gain access to intertoll trunks, thus obtaining access to the line-haul facilities, remote toll central office, local facilities, and Subscriber D. The intertoll grade trunks (line haul) interconnect with toll switching central office facilities that switch traffic on a four-wire toll transmission performance basis (as opposed to the lower performance two-wire switching in the local exchange). The intertoll grade trunks are made up of the same type of facilities as the interexchange trunk facilities. The toll central office provides tandem trunk switching and traffic routing functions, which allow traffic to be switched within the central office switching hierarchy. These toll central offices principally comprise enhanced crossbar or (to a limited extent) electronic switching technology. At any central office level, traffic may be routed to a distant Class 1, 2, or 3 office, or a combination Class 4/5 office, or a Class 4 office to access a remote Class 5 office for interconnection to a distant customer, such as Subscriber D in the Dallas (Area Code 314) 957 local exchange. Thus, the subscriber is connected via a local access line to his serving central office, and a toll call may be completed through an elaborate and extensive nationwide switching hierarchy that may route a call through many possible variations of Class 1, 2, 3, 4, and 4/5 network variations. Line-haul trunking is provided by various types of high-capacity transmission facilities such as the following:

- N carrier (analog carrier systems that will carry as many as 36 voice-grade channels over two cable pairs). These systems are considered old technology and are used primarily for short-haul facilities (less than 250 miles).

- T1 carrier (digital carrier systems that will carry 24 voice-grade channels over two cable pairs). These facilities are commonly referred to as 1.544 Mbps digital lines and are considered new technology.

- Microwave radio and wide-band coaxial systems. These systems are generally high-capacity systems (600 to 3,600 channels) and are designed for long-haul transmission (where circuits are to be be carried more than 250 miles).

- Satellite communications links. These are also used to provide long-haul communications facilities. Satellite facilities are used less than terrestrial facilities for many applications because of time delays (1/4 second per hop). These delays are a problem because of user-acceptance problems in voice communications and longer turn-around times for data applications.

Variations of the domestic telephone system generically illustrated in Figure 3-1 are used to provide certain services such as Bell's WATS, FX, or private line. In the case of WATS, high-use line switching equipment is used in the local central office together with automatic message accounting for billing purposes. In the case of FX, local and toll switching is bypassed at the originating end and toll switching is bypassed on the receiving end. In the case of the private line, all local and toll switching is bypassed.

Different combinations of the domestic telephone system facilities are required to provide a range of services, and therefore there are different investment requirements and associated annual operating costs to provide these services. This difference in costs between services is a key element of this study.

3.3 TECHNOLOGIES AVAILABLE TO PROVIDE SERVICES

Most of the technology required to provide interstate carrier service is associated with transmission and switching systems, although six major categories of plant are utilized:

- Land and buildings used chiefly to house switching and other circuit-related equipment
- Central office equipment: switching, carrier terminals, frames, battery, back-up, and other communications-related equipment
- Exchange lines and trunks: subscriber lines and trunks for intra-exchange and interchange calling
- Toll lines: trunks between central offices or other switching points used for calls bearing a toll (or long distance) charge
- Station equipment: basic telephone instruments and other instruments such as key sets, PBXs and associated common equipment, modems, and data terminals
- General equipment: motor vehicles, tools, furniture, fixtures, and other items incidental to carrying on the business and not classifiable in one of the other categories

Table 3-3 lists the switching technologies (manual, panel, step-by-step) used by Bell in 1973 and 1978. These two years have been selected to illustrate the change in mix of technologies that has occurred in five years. For instance, the table shows that all technologies except the electronic switching system have decreased in number of systems in service, the most drastic reductions occurring in the step-by-step category. This technological trend indicates that Bell is replacing existing systems and meeting new growth requirements with the new electronic switching technology (ESS) to benefit operations and subscribers. The benefits of the ESS technology that have prompted this trend are the following:

- Maintenance of ESS costs less than the electromechanical technologies of the other system types.

Table 3-3. SWITCHING SYSTEM TECHNOLOGIES IN SERVICE FOR THE BELL SYSTEM OPERATING COMPANIES*				
Technology	1973		1978	
	Number	Percentage	Number	Percentage
Manual	3	Negligible	0	0
Panel	268	2%	32	Negligible
Step-by-Step	8,527	52%	6,934	38%
Crossbar	6,482	39%	6,552	36%
Electronic	1,203	7%	4,603	26%
Total	16,483	100%	18,121	100%

*Source: Federal Communications Commission, *Statistics of Common Carriers*, 1978.

- The ESS technology can provide better call service to the subscriber and more efficient and sophisticated network switching performance than the other technologies. Crossbar switching may be fitted with computerized processors (common control equipment or "markers") to allow enhancements that may keep crossbar technology alive for some time.
- ESS technology can provide the subscriber with sophisticated calling features that the other technologies cannot cost-effectively provide. The following are examples of thiese features:
  - Speed dial: a customer need dial only two digits to call a frequently dialed customer.
  - Call forwarding: a customer may instruct the ESS machine to forward all calls to another station.
  - Call waiting: a customer who has a call in progress is informed by an ESS signal that a caller is attempting to reach him.

Technology has advanced further than the ESS; digital local (Class 5) and toll (Class 4) central office equipment is now available. Digital switches rely on conversion of speech into a digital information stream by a process known as pulse code modulation (PCM). After conversion, normally, 24 voice circuits are time-division-multiplexed (TDM) into a serial bit stream that has a bit rate of 1.544 Mbps. This is the classical T1 transmission technology developed in the 1950s, which has rapidly

expanded into the switching categories of plant. The following are the major advantages offered by the new digital technology:

- Improved signal-to-noise ratios due to regeneration of digital signals
- Reduced trunk interface costs due to direct connection of T1 lines to digital end offices and other switching points
- Ease of implementation of remote switching sections interconnected to master nodes by means of T1 lines. The remote digital switching section is a remote switching matrix controlled by the master processor and associated software. This reduces the unnecessary duplication of software and processor costs in the remote switching unit.

Another major technology used to provide interstate services is microwave radio and carrier systems. Table 3-4 lists six major types of microwave radio technologies used by Bell. This type of transmission technology provides short- and long-haul facilities (short-haul is less than 250 miles) for major backbone and distribution routes in the United States. Each radio system uses an analog frequency division (Type L) multiplexing. The most modern system in widespread use is the TL-2/TM-1, designed for short-haul applications. The Bell system has also developed a "pole line" 18 GHz high-digital radio system (not included in Table 3-4) and has also purchased digital radio systems from manufacturers such as Raytheon, Nippon Electric Company, and Avantek for applications where carrier cross sections are T1 in nature or are more economically provided by T1 lines. The trend toward digital radio systems is being spurred primarily by the following:

- The noise properties of fully regenerated (repeated) T1 lines are nonadditive.
- Digital coaxial systems or other digital facilities sometimes have to be interconnected by long-haul facilities.
- Digital radio is sometimes more economical than digital cable operations.

Table 3-5 lists the various types of carrier technology used to provide repeated terrestrial facilities longer than 25 miles. The C-carrier equipment provides 3 voice-grade circuits over open wire and has a repeater spacing interval of 150 miles. J-carrier is a 12-channel system for open wire use and requires repeaters every 50 miles. K-carrier is a 12-channel system for cable use (two 19-gauge unloaded pairs) with repeater spacings like those of the K carrier.

L-carrier facilities are used with coaxial cable or radio relay systems. The original system, L1, was engineered to provide 600 voice channels over a pair of coaxial conductors with 8-mile repeater spacings. L3-carrier is a later development that will provide a capacity of up to 1,860 voice-grade circuits, repeater spacings about every 4 miles. A newer system called L4 carries 3,600 circuits per pair of coaxial conductors

Table 3-4. BELL SYSTEM MICROWAVE RADIO TECHNOLOGY BY TYPE OF RADIO SYSTEM

Type of Radio System	Radio System Application	Channels (2-Way)		Total	Per Channel Telephone Circuits With Type "L" Multiplexers	Frequency of Operation (GHz)
		Working	Protection			
TD-2	Long-Haul Low-Capacity	10	2	12	600	3.7 - 4.2
TD-3	Long-Haul High-Capacity	10	2	12	1,200	3.7 - 4.2
TH	Long-Haul High-Capacity	6	2	8	1,860	5.925 - 6.425
TJ	Short-Haul Low-Capacity	3	3	6	600	10.7 - 11.7
TL	Short-Haul Low-Capacity	3	3	6	240	10.7 - 11.7
TL-2/TM-1*	Short-Haul Low-Capacity	6	6	12	600	TL-2 10.7 - 11.7 TM-1 5.925 - 6.425

*Cross-band diversity system protected against propagation disturbances in either the 6 GHz or 11 GHz band.

Table 3-5. CARRIER TECHNOLOGY, CAPACITY, AND TYPE OF TERRESTRIAL FACILITY			
Type of Carrier	Number of Channels	Plant Type	Type of Technology
C	3	Open Wire Pair	Tube/Analog
J	12	Open Wire Pair	Tube/Analog
K	12	19 Cable Gauge Unloaded	Tube/Analog
L1	600	Coaxial Cable Pair	Analog
L3	1,860	Coaxial Cable Pair	Analog
L4	3,600	Coaxial Cable Pair	Solid State/Analog
N	12	Cable	Tube/Analog
O	16	Cable	Tube/Analog
ON	20	Cable	Tube/Analog
N3	24	Cable	Solid State/Analog
T1	24	Cable	Solid State/Digital
TN-1C	48	Cable	Solid State/Digital

and requires repeater spacings every 2 miles. These systems are considered high-capacity long-haul cable plant and voice carrier systems capable of meeting toll noise and other transmission objectives.

The N-carrier systems are designed to provide 12 voice-grade circuits on two nonloaded pairs of toll or exchange cables over a distance ranging from 20 to 200 miles. Repeaters are required every 8 miles with a 19-gauge cable plant design. Type O-carrier is used to provide predominantly short-haul carrier channels over open wire conductors. The system is capable of providing 16 voice-grade channels on a single pair of open wires. Repeaters are required at intervals of 25 to 60 miles, depending on the transmission design associated with the open wire facilities. Type ON carrier is a combination of the N and O systems previously discussed. The O-carrier channel groups are converted so that transmission may be effected on the same line as the N-carrier facility. This system has a capacity of 24 voice-grade circuits. The N3-carrier system also provides 24 channels and is considered modern because it is solid-state; however, N3 is rapidly being phased out by the newer T1-carrier, digital systems. As discussed earlier, the T1-carrier system is a solid-state, 24-channel system that uses time-division multiplexing (TDM) and pulse code modulation (PCM) and has a line bit rate of 1.544 Mbps. The T1-carrier lines operate over two cable pairs, one for each direction of transmission, and repeaters are required every 6,000 feet on 22-gauge subscriber cable facilities.

Most of the cable systems in use by Bell have been providing interchange trunk transmission facilities for many years. The older analog systems are not being used in most carrier plant applications, having given way to the newer Tl-line technology. In 1974 International Telephone and Telegraph (ITT) introduced a 3.0 Mbps system called T-1C, which took two Tl-line channel bank facilities and multiplexed them into a 3.0 Mbps bit stream for transmission over the same repeated facilities that support Tl lines (new 3.0 Mbps repeaters have to be installed in place of the 1.544 Mbps repeaters). In this fashion the capacity of a carrier cable could be doubled by means of repeater changeout and the addition of common end-terminal multiplexer equipment. At about the same time, the New York Telephone Company cut into service between Albany and Troy, New York, an experimental 11 GHz digital radio system developed in concert by the operating company and Raytheon Data Systems. This system marked the first provision of high-capacity digital facilities that could provide major haul of Tl lines. This radio system transmitted two 40 Mbps bit streams (80 Mbps) over a single frequency pair. The Nippon Electric Corporation in 1974 provided equipment for a 100 Mbps repeated digital coaxial cable system, which placed in service the first high-capacity transmission system. The initial use of both types of transmission facilities marked the start of a digital era in transmission, which would spread to switching later when Northern Telecon announced the development of its first digital end-office, the DMS-1, in 1975. This office allowed direct termination of 1.544 Mbps lines without channel banks, which saved up to $6,000 in a single end terminal investment per Tl line. In addition, remote subscriber switching equipment interconnected by Tl lines could economically decentralize switching facilities into the subscriber serving areas that had feeders with routes longer than 60,000 feet.

Recently, the use of fiber optics has become practical for certain transmission applications, when high-capacity facilities are required. This technology represents an alternative to coaxial and copper cable plant in both the haul and subscriber feeder route portions of plant design. It is expected that this technology will mature and come into full acceptance as a transmission alternative over the next 15 years.

In terms of technology, switching and radio/carrier transmission represent the largest share of existing plants. Satellite transmission accounts for a small plant investment and is used primarily for long-haul communications, although the use is constantly increasing. Our study will address both terrestrial and satellite transmission cost trends.

3.4 INTERCITY COMPETITION

In the previous sections we have discussed the present and prospective technologies used in the provision of domestic telecommunications facilities. Many of the Bell facilities in service at any time are of out-dated technology, because enormous capital investments and homogeneous extension of facilities preclude rapid changes in technology.

However, as discussed in Chapter Two, the advent of the microwave radio in the 1950s significantly reduced the impediments to private and competitive transmission facilities. Large corporations having heavy communications requirements between specific cities could construct their own microwave transmission facilities and provide an economic alternative to Bell-provided facilities. This possibility stimulated the Above 890 FCC decision, which opened the door to competition in the telecommunications industry.

Subsequently, new entities sought FCC authority to provide private-line services on a common-carrier basis. In 1971 the FCC concluded that free enterprise in the private-line business would best serve the public interest. The FCC cited unmet user requirements for specialized facilities (especially for data facilities) and the need to stimulate communications innovations that might flow from the free-enterprise process.

This initial phase of competition in the intercity marketplace was stimulated by three main issues:

- Technological changes that allowed competitive alternatives to the monopoly right-of-way cable facilities
- User needs that were not being satisfied by the existing domestic monopoly
- The desire of the FCC to remove judiciously the regulatory barrier to competitive entry into the communications marketplace

In our studies we have noticed that the opening of the marketplace to competition has served to stimulate a more creative approach to marketing both basic transmission and enhanced services. Examples of areas affected are as follows:

- Pricing innovations. Specialized carriers have offered discounts based on quantities of circuits and terminals leased by a customer. SPCC, for example, offers a price discount based on the customer's agreeing to lease a circuit in service for specified lengths of time.
- Service innovations. Competition has stimulated provision of new services or reconfiguration of existing services in order to attract customers. For instance, MCI offers telemanagement, which provides to customers who do not have intelligent PBXs advanced network functions such as least-cost routing and optimization and traffic and network management. Large and small customers who take advantage of this particular service enjoy the benefits of telecommunications optimization without spending a lot of money to develop the capability.

  Another innovation is the MCI shared private-line service (SPLS) offering, which allows low-volume users a method of sharing private lines (first offered in 1975). The rate structure for this service is based on the customer's share of the cumulative total monthly use of all shared lines.

- Service costs. There has been substantial user acceptance of OCC services due to economic savings. For instance, SPCC's SPRINT offering provides 34 to 54 percent savings over credit card calls and up to 41 percent savings over DDD, and provides substantial cost-per-minute savings over Band 5 measured-time WATS for calls made between 90 SPCC city pairs. Since access to the service is through the domestic telephone system, subscribers do not have to make capital investments in switching equipment or wait long for facility installation. In fact, SPCC sales personnel say that the service can usually be started on the day of order.
- Merchandising. The OCCs are probably best described as aggressive and anxious to sell services, and their advertisements reflect this disposition. For instance, MCI has started marketing EXECUNET to the residential market with a TV advertising company in Denver. One ad, half-way through an afternoon soap opera, carries the marvelous punch line "You haven't been talking too much. You've just been paying too much." The OCCs actively sell alternatives in an industry that historically has preferred to allow a customer to use the MTS and has not actively marketed cost-effective alternatives (e.g., WATS and private-line service).

In general, competition has been beneficial to telecommunications users and is expected to influence telecommunications in a positive fashion. The rapidity with which competitive alternatives have multiplied is made vivid by a comparison of the situation today and that in 1969. In that year there were only five manufacturers of key systems and PBXs. Now a rough count shows that 26 key systems and 35 PBX manufacturers are marketing 190 different PBXs and more than 70 key systems. In 1969 there was only one long distance supplier; now there are more than 10, and the number of ways of communicating between cities has risen exponentially.

3.5 INFLATION-RELATED COST DRIVERS

This section summarizes the exposure of services to inflationary processes in certain key areas in order to set the stage for determining future costs on the basis of present and future trends. Amelioration of the effects of inflation can come from four key areas:

- Technology
- Operating efficiencies
- Exposure of existing plant to inflationary pressures
- Management

3.5.1 Technology

As stated earlier, new technology is the lifeblood of the OCCs. In fact, most plant consists of current technology, and since there is minimal

vertical integration* of R&D and equipment production by the OCCs (as compared with Bell), there is significant benefit to the OCCs. This is dramatically exemplified by the independent telephone companies, which are for the most part not vertically integrated. The quick introduction of digital technology by these companies has brought a proliferation of digital switches since 1977, and in response Bell is proposing to install digital offices in the first quarter of 1982. The OCCs were simply not tied to what their R&D teams and manufacturers thought was best or could be done under various imposed constraints.

New technology has to be relevant to the needs of the customers as well as to the operating benefits and profits of the carrier. For instance, since Bell introduced the high-capacity L5 coaxial system, circuit use has been running less than 20 percent. The cost burden of carrying such excess capacity would bury a starting common carrier because there would be no economies of scale to enable an attractively priced intercity service. Thus, the OCCs must make efficient use of technology because they have no corporate largeness over which to spread unfortunate market ventures, inability to sell capacity, and loss of customers due to service problems or inability to bring in new technology and service features.

3.5.2 Operating Efficiencies

If the bulk of existing plant is provided by new technology, which requires fewer labor hours for installation and ongoing maintenance and administration, there is less vulnerability to the impact of inflation on the labor content of installation and overall operations. Thus, the rate of change of cost of service with respect to time, that is, its costs of service velocity, will be lower than for services provided by a carrier that has other, more labor-intensive types of plant technology.

3.5.3 Exposure of Existing Plant to Inflationary Pressures

A carrier is vulnerable to the pressures of inflation in varying degrees, depending on the vintage of its technology and on the labor and administrative requirements essential to the conduct of operations. The extent of sensitivity can be ascertained by breaking down the carrier's existing plant into its component capital cost structure and operating costs by technology and facility. The investment and operating costs can then be factored into annual labor and capital-related carrying costs. For instance, labor would include all costs of maintenance and administrative labor hours on an annual basis, and capital-related costs would include composite return on investment, depreciation, ad valorem taxes, and federal income taxes. The labor-related costs will varying with labor settlements that are explicitly connected with the rates of inflation experienced by the overall economy. This is the major portion of operating costs that will be exposed to inflation. The costs of money and federal

*Vertical integration means that a carrier's complete R&D and manufacture and installation of equipment are all part of the same corporate entity as the provider of services.

income tax components are less directly connected with inflation rates experienced by the economy, as will be discussed in subsequent chapters. The extent of exposure to inflation rates experienced by the economy will also be discussed in Chapters Six and Seven, where trends are analyzed and projected. Each carrier studied does possess a characteristic cost structure and has a varying degree of response to changes in inflation rates associated with labor and communications equipment.

3.5.4 Management

An important aspect of the selection of technology and the conduct of business (e.g., maintenance, marketing, engineering) is the overall management of the business. In the interstate carrier business, the effectiveness of management can probably be determined over a 20-year period because short-run effects are not indicative of the ability of management to come to grips successfully with the many serious issues that may affect operations. Among these key management issues are the following:

- Dominant carrier manipulation of the market by pricing, regulatory and judicial intervention, marketing campaigns, and cross-service subsidization of competitive services by monopoly services
- Inability to attract capital during adverse periods of capital formation
- Lack of large customer base and service diversification, which presents an unstable financial position, given shifts in subscribers between companies due to price- and service-related elasticities
- Technological advantages that tend to normalize in time. In this instance the carrier must have sold its customers a substantial percentage of their communications needs, so that they will not take their business elsewhere because of a single factor.

In short, the viability of a carrier rests in the hands of its management.

CHAPTER FOUR

FACTORS AFFECTING CONUS COMMON CARRIER OFFERINGS

4.1 OVERVIEW

Chapter Three described the characteristics of the operating and cost structure of the industry under study. In this chapter we describe the factors that have changed the nature of this industry and that will play a major role in shaping the industry's future. The factors of key interest are legislative, judicial, regulatory, technological, and economic. We will review these factors to determine their influence on the common carrier industry and associated services to the user. We will examine the nature of this influence to establish whether it will cause the following:

- Short- and long-run increases in service rates due to increased costs
- Long-run increases or decreases in rates due to increased or decreased competition
- A long-run withdrawal of a service due to regulatory, judicial, or cost pressures, or all of these
- A normalization of technology and rates
- Restriction of "free entry" into segments of the interstate market

For each factor we will design scenarios describing worst-case, best-case, and expected-case effects on services offered by the industry. These scenarios will be used later in this report to develop cost-of-service trends.

4.2 LEGISLATIVE FACTORS

Efforts are currently under way by leaders of both houses of Congress to make extensive revisions to the Communications Act of 1934, which provides the legal foundation for the regulation of a variety of communications services. In recognizing the need to rewrite the Communications Act, Congress is mindful that present telecommunications services embodied by sophisticated technologies such as computers, satellites, digital transmission, and switching are governed by an act that was taken in part from the nineteenth-century Interstate Commerce Act.

In 1979 members of the House Subcommittee on Communications abandoned efforts to rewrite the Act completely and decided to propose changes as amendments to the original Communications Act. The present bill (HR 6121), released in December 1979, proposes to amend the Act. The proposed amendments focus on common carrier issues and do not address broadcasting problems, which have proven to be highly controversial. The Senate Subcommittee on Communications, in support of the House Subcommittee, released two controversial bills (S 611 and S 622), which were later redrafted.

The three bills propose drastic restructuring of the entire regulated telecommunications industry. All three bills would extend the FCC's jurisdiction over the nationwide telephone service, a change that would result in the FCC's regulating intrastate -- i.e., interexchange -- services in addition to its current interstate domain. This would effectively remove intrastate toll and interexchange service from state public service regulation. Additional key elements of the three bills are as follows:

S 611

- Requires the FCC to establish rules to impose pricing separation of terminal equipment from data processing services offered as part of a communications service
- Abolishes the current separations and settlement structure, which allocates costs of toll calls over local and long-haul facilities for appropriate telephone company reimbursement, and forms a joint federal and state board to administer a nationwide program of subsidization of local carriers whose cost of service is 20 percent or more over the national average
- Separates AT&T's marketing and terminal equipment manufacture into separate subsidiaries

S 622

- Requires FCC actions affecting carrier subsidiaries to be supported by FCC-developed cost-benefit studies
- Limits rate changes to a 10 percent increase or a 20 percent decrease in any year
- Institutes nationwide rate averaging within three years and abolishes the separations and settlement structure

HR 6121

- Places AT&T marketing in a completely separate subsidiary, terminal equipment manufacturing to remain with the parent company
- Completely revises separations and settlements, substituting an access subsidization of exchange service
- Allows local and long-distance telephone services to remain under AT&T

As drafted, the total effect of the three bills is to further regulate and control telecommunications at the federal level. The timing of the passage of the proposed legislation is not clear. It appears that the pending legislation has lost its initial momentum; however, there is a good chance that a revised communications act may take effect in the early 1980s. It is clear that the political forces involved in the drafting of the legislation will address the key issues of competition, telephone company subsidization, and regulation. The possible effects of these issues are presented in Table 4-1. The pending legislation will have significant effects on the telephone industry, federal and state relationships, and the FCC's ability to oversee telephone industry rates effectively. The legislation in its final form may provide a drastic restructuring of the domestic telephone industry and federal regulation.

Table 4-1. MAJOR ISSUES AND POSSIBLE EFFECTS OF NEW LEGISLATION

Major Issues	Possible Effects
Competition	Stimulation of competition
Subsidization of Basic Telephone Services	A mechanism to provide economic support for rural and basic residential services. This implies that business-related services will support subsidization.
Regulation	Expansion of FCC regulatory powers into the heretofore state-regulated intrastate toll and interexchange services

If the pending legislation becomes law, it will have an impact on both the telecommunications industry and the user of telecommunications services. The effects of the passage of the pending legislation on the industry (and hence on the user) are listed in Table 4-2 in terms of worst-case and best-case outcome. With reference to the eight major areas affected by the new legislation, Table 4-2 shows that a worst-case outcome is highly inflationary, impedes changes, slows the incorporation of technology, and presents a major impediment to free enterprise. A best-case outcome allows free market forces to prevail and legislative and regulatory functions to assume a position actively ensuring free competition.

4.3 JUDICIAL FACTORS

4.3.1 Justice Department Antitrust Suit

In 1974 the Antitrust Division of the Justice Department filed a civil antitrust suit (Case No. 74-1698) against AT&T and its operating companies. The suit stated that it was more concerned with the issue of "competition" than the "bigness" of the AT&T monopoly. Filed in the Federal District

Table 4-2. WORST-CASE AND BEST-CASE SCENARIOS FOR PASSAGE OF THE PENDING COMMUNICATIONS LEGISLATION

Areas Affected	Worst-Case Outcome	Best-Case Outcome
Plant Investments Required for Operation	Short- and long-run effects, higher unit costs due to labor and equipment price increases resulting from separated subsidiaries	• Decreases in investment costs due to focusing of new technology and reduced equipment prices caused by competition • Decrease in labor requirements for installation and maintenance
Operating Expenses	Short- and long-run inflationary effect due to depressed business conditions and adverse labor climate	Decrease in labor requirements for maintenance due to increased use of new technology
Capital	• Very high cost of capital due to investor perception of risk • Substantial pressure from stockholders for higher return	• Easy acquisition of capital at competitive market rates due to perception of minimal risk • Adequate earnings due to favorable business conditions
Competition	• Reduced competition due to inability of OCCs to fund capital expansion • Reduction of new service offerings by regulatory slowdown of technology infusion	• Increased competition due to legal and regulatory effects • A much larger market for Western Electric • Much activity by AT&T, which, however, is kept from underpricing services • Stimulation of market demand by OCCs through innovative uses of pricing, technology, and new service offerings
Regulation	• Regulatory bottleneck due to inability to mediate industry problems and social consequences • Hampering of beneficial regulation and change by political pressure • Retardation of private commercial incentives by overregulation	• Limiting of regulatory efforts to major monopoly pricing issues in competitive service areas. In non-competitive areas, regulation of business service standards and control of pricing and subsidization • Unhampered commercial incentives
Local Service Rates	• Low limits on rates to offset adverse public pressure • High installation costs for new telephones, reflecting high labor costs	• Low limits on local service rates • Moderate installation costs to encourage use of services
Toll Rates	Interstate increases and intrastate decreases due to rate averaging	Moderate increases in interstate rates to match return on investment levels allowed for intrastate services. Moderate increases in intrastate rates.
Business Service Rates	• Significant increases in business rates, with residential rates held low • Formation of business pressure-groups to further interests and satisfy needs	Moderate increases in business service rates, which reflect requirements for interstate rates to achieve return levels comparable to intrastate services

Court in Washington, D.C., the suit was the second attempt of the Justice Department to pressure AT&T in an antitrust action. An earlier antitrust complaint was settled in a consent decree in 1956. The major outcome of the consent decree was that AT&T agreed to nonparticipation in any data-processing-related services. The present suit calls for divestiture of Western Electric Company (AT&T's manufacturing operation), fracturing "Western Electric into two or more competing firms in order to insure competition in the manufacture and sale of telecommunications equipment." In addition, a partial separation of the AT&T Long Lines Department was also asked. AT&T's response to the suit was to go to court and seek dismissal based on the unsuccessful 1956 resolution of similar divestiture matters. Significant pretrial activities have taken place preparatory to trial in September 1980.

This suit will have a far-reaching effect on AT&T's structure and ways of doing business. The effects of divestiture are purely speculative, because there is no precedent. For instance, there is no single terminal equipment manufacturer that could produce the entire PBX equipment order that the New York telephone company places in a given year, let alone the entire purchase requirement of the operating subsidiaries of AT&T. This indicates that Western Electric would still enjoy a substantial captive purchasing relationship with the operating companies. AT&T purchasing power would essentially control any private manufacturing entity through its ability to influence price, production quality, standards, development, and other matters of procurement.

4.3.2 Other Judicial Activities

On 14 January 1980, the U.S. District Court in Bridgeport, Connecticut, awarded an interconnect company, North Eastern Telephone Company, $16.5 million in damages. This award climaxed an antitrust suit initiated in 1974 against AT&T and Southern New England Telephone Company (a Bell subsidiary). Charges had been made that Bell had blocked the sale of interconnect key and PBX systems through the use of the following anticompetitive practices: (1) products were announced before tariffs were filed, (2) AT&T's business rates and two-tier pricing were predatory, and (3) rates for protective devices required on interconnected trunks were anticompetitive and were a substantial deterrent. In another suit, Microwave Communications, Inc. (MCI), filed an antitrust action against AT&T in 1974. This suit, which seeks $1 billion in damages, went to trial in Chicago in February 1980. Issues surrounding this suit involve AT&T's alleged anticompetitive policies and practices in its interstate business.

In February 1980 the U.S. District Court of the Southern District in New York approved a settlement in the ITT-vs.-AT&T antitrust suit that had been initiated in 1977. Under the approved agreement, AT&T would purchase up to $2 billion in equipment, which would comprise most digital exchanges in the next ten years, given that ITT's prices were competitive. Bell was required to make a $100 million deposit in 1980 and another in 1984.

In March 1980, AT&T and DATRAN (owned by the Wyly Corporation) reached a settlement in their antitrust suit, in which DATRAN claimed anticompetitive pricing by Bell. As part of the settlement, Bell will pay the Wyly Corporation $50 million, much less than the original claim of $315 million.

In general, AT&T has not fared well in antitrust suits. AT&T has had to evolve from a regulated monopoly with a service-related market structure into a competitive operation, and the associated growing pains have been costly. The effects of forced divestiture of AT&T's subsidiaries will profoundly change AT&T's operations. It is expected that a worst-case outcome for AT&T will have the following effects:

- Increases in equipment prices due to lack of manufacturing control
- An appearance of risk in the capital market that will tend to increase AT&T's cost of debt and equity
- An increase in competition for equipment manufactures. However, little benefit will pass through to subscribers, because of higher unit costs and relative normalization of equipment pricing structures.
- Severe regulatory restrictions in competitive services, which will result in large losses of AT&T market shares, thereby increasing the business handled by the OCCs. The large loss of market shares will cause AT&T's prices to escalate because of low utilization of high-capacity plant facilities.
- An increase in intra- and interstate rates as well as local service rates
- Heavy price increases in Bell-provided business services (increases that cannot be levied upon residential subscribers)
- Deceleration of technological growth due to decreased control over high-cost technology R&D and manufacture. Large foreign corporations immune from divestiture, such as Northern Telecom (Canada) and Nippon Electric Company (Japan), will flourish and replace the American technological initiatives.

In summary, the effects of this worst-case outcome of the AT&T divestiture are a substantial inflationary pressure on the domestic telephone industry and the deferment of technological innovation.

4.4 REGULATORY FACTORS

In the interstate regulatory arena, there are twelve major active areas of regulation, as described in the following subsections.

4.4.1 Account Revisions

The FCC uniform system of accounts (USOA) has been in existence since 1913. The USOA has gradually become outdated because of extensive service

diversification and a need for increased accounting details for revenue, plant, and expense. In 1978 the FCC initiated a rule-making docket (Docket CC 78-196) designed to consider the complete revision of the USOA. The new USOA will provide a "regulatory information system" that will meet the needs for regulating large common carriers.

4.4.2 Basic Data Services

AT&T's dataphone digital service (DDS), introduced in 1974, provides digital service at rates lower than the AT&T standard 3000 private-line rate. The FCC's Docket 20288 (1974 to 1979) investigated AT&T's rate-making principles for the DDS service, charging that the company's rates were too low and anticompetitive. Regulatory investigations are still continuing. AT&T adjusted rates to higher levels in 1977; these newer rates were still found to be anticompetitive, and the general thrust of the current proceedings is to increase service rates to compensatory rate levels.

In 1975 AT&T offered its 1.544 Mbps DDS service under Tariff 267. Petitions were filed by DATRAN and the Department of Defense charging that the rates were anticompetitive compared with the rates charged for lower-speed DDS services. The FCC initiated Docket 20690 to investigate these allegations; however, the rates were allowed to take effect pending resolution of the investigation. The scope of Docket 20690 was expanded to include Tariff 268, which offers the same service to other common carriers. In 1978 the FCC rejected AT&T tariff revisions that would limit the offering of the service to the Washington, D.C., area only. In 1979 the courts rejected Bell's rates and ordered refunds to the DoD. This case is still active, and resolution is expected in 1980 or 1981.

4.4.3 Dataphone II Offering

In 1979 AT&T filed tariff revisions offering a service known as "Dataphone II": automatic data system testing of remote modems from a central site without interruption of data circuits. A number of petitions for rejection or suspension have been filed. The tariffs were allowed to go into service in April 1980 after the FCC examined complaints of AT&T's "premarketing" Dataphone II by the Independent Data Communications Manufacturers Association.

In this case regulatory interaction had restricted the Dataphone II service offering, which was new and not offered by another carrier. Not only was technological change held up, but also the regulatory arena was used to delay AT&T marketing. Premarketing is not unusual in the electronic equipment business; similar delays have occurred with microwave radio, PBX, Key, and other telecommunications equipment marketed by independent manufacturers.

4.4.4 Deregulation

The Docket 79-252 proceeding was begun in 1979 to examine the possibility of reducing regulatory requirements for carriers that were small and not considered in an "eminent" market position; dominant entities would include Bell, some independent telephone companies, and "perhaps" Western Union. As part of Docket 79-252, the FCC began to examine regulatory reform independently of the congressional efforts. This investigation is being undertaken in two phases:

- Phase I is a proposal to ease the carrier's burden of filing tariff notice intervals. The Commission proposes the addition of a new section (61.39) to the rules, which would eliminate the need of any authorization for additional facility requirements. In addition, it is proposed that the carriers be allowed to withdraw services on a 30-day notice; currently a formal FCC petition is required.
- Phase II proceedings will ask the general public to comment on whether the FCC has a mandate to decide not to regulate certain services at all. The implication of this proceeding is that the FCC may hold that certain carrier offerings are not common carriage and thus would not come under its scrutiny.

4.4.5 AT&T Equipment Procurement Entity

In 1977 the FCC indicated in its General Rate Case decision (Docket 19129) that although action on Bell's relationship to Western Electric Company was not warranted, it would like to see greater "Bell operating company autonomy and independence from Western Electric in equipment procurement," and it asked AT&T to submit plans that would achieve this objective. AT&T announced the development of a wholly owned subsidiary that would evaluate both Western Electric equipment and independently manufactured equipment for use by the Bell operating companies. The plans were submitted in 1978, but little action has resulted. In 1979 ITT petitioned the FCC to persuade AT&T to allow more independent Bell equipment procurement.

FCC Docket 19129, initiated in 1971, examined the basic issue of Bell's relationship with Western Electric with a view toward solving by divestiture the problem of alleged predatory pricing by Bell in the terminal equipment market. As mentioned earlier, the status of Western Electric has also been considered by Congress as it has deliberated the rewriting of the Communications Act of 1934. Current versions of the pending legislation do not consider complete divestiture; however, the conversion of Western Electric into separate subsidiaries is not being considered. The Department of Justice, in its antitrust suit against AT&T, is expected to look at divestiture, but the judicial process is expected to be fairly time-consuming. This proceeding will certainly reflect an FCC effort to maintain regulatory control, which will reduce anticompetitive posturing by AT&T. It is expected that competition by independent manufacturers for Bell business will grow keen and that there will be expanded efforts to develop unique new technologies.

4.4.6 General Rates and Cost

The current rate and cost issues focus on private-line rate-making and AT&T's rate of return. A summary of issues and events related to these two areas is presented in the following subsections.

4.4.6.1 Private-Line Rate-Making

In 1968 the FCC initiated Docket 18128 -- the private-line rate-making inquiry. Since 1968 the FCC has attempted to develop suitable methodologies for determining appropriate costs of services provided by AT&T. These deliberations affect business, residential, governmental, and all other users of the domestic interstate telecommunications services. Since the 1976 decision in this case, the FCC has worked with Bell to develop a proper method for determining cost of service. The method developed is known as the fully distributed cost (FDC) approach. The rate-making effort of the FCC effort is 12 years old and still undergoing change. The general effect of FDC costing is to ensure that revenue requirements are based on the full cost of service and do not reflect possible distortions that may occur with cost techniques such as the previously used incremental cost approach.

In Docket 79-245 (1979) the FCC sought to develop a new cost manual based on FDC procedures. This docket will test the FDC procedures developed in Docket 18128. The FCC has also established interim FDC procedures different from the previous recommendations. In addition the new docket is seeking comments on issues such as the following:

- Whether additional data submission requirements should be imposed on Bell
- Whether unit costs should be derived from a division of revenues or through special studies
- Whether the concept of facilities available for future growth is viable
- Whether AT&T's cost allocation and reporting process is too complex

Similar proceedings took place in the Multischedule Private Line (MPL) Inquiry. Under Docket 20814, AT&T was required to justify its current MPL rates by FDC methods. In 1979 the FCC found that the FDC cost manual (developed in Docket 20814) did not meet original requirements. The FCC also judged the MPL rates to be unlawful and divided the issues of Docket 20814 into two new proceedings:

- Docket 79-245 - to develop a new cost manual
- Docket 79-246 - to look at AT&T's private-line rate structure

The key element in all these proceedings is the fact that the FCC has been unable to develop a suitable cost methodology with which to examine AT&T's cost and rate structure.

4.4.6.2 AT&T's Rate of Return

In 1972 AT&T was authorized by the FCC, in Docket 19129, to establish a rate of return for interstate services in the range of 8.5 percent to 9.0 percent. In 1976 AT&T was allowed 9.5 percent to 10 percent as a result of the final decision in Docket 20376, which examined AT&T's return in equity. In 1979 the commission initiated a new rate-of-return inquiry, Docket 79-63. AT&T had petitioned the FCC for a 16.38 percent interim increase and a permanent increase to 12.0 percent, giving the following as the main reasons:

- The company would otherwise suffer from investor perception of risk due to increased competition and changing regulatory conditions.
- The 12 percent rate of return would increase internal efficiency and generate internal capital.

Concurrently with Docket 79-63's inquiry into a possible higher rate of return for AT&T, the FCC instituted Docket 79-187 to investigate the excess earnings that Bell reported in 1978. These earnings were more than the 9.5 to 10 percent level earlier authorized for Bell. The alternatives considered by the FCC present a dilemma and are the subject of the present Docket 79-187 proceeding.

In 1979 the FCC indicated that it planned to initiate an inquiry into AT&T's productivity and efficiency. Proceedings have not been held as yet. The findings of the proceedings will mesh with the Docket 79-63 proceedings, which, as mentioned earlier, will examine AT&T's current and future rate of return. It is expected that these proceedings will be held in 1980.

4.4.7 MTS, WATS, and Other Competitive Services

As discussed earlier, the prevailing regulatory climate ensures free competition in the interstate marketplace by regulating the dominant carriers and deregulating the OCCs. Consequently, there was not a clear regulatory distinction between point-to-point private-line services and switched services that use the same facilities. In 1974 MCI introduced EXECUNET(R) service, which allowed customers to use local exchange service in any Bell area to call (over MCI long-haul facilities) any telephone in other cities where the service is offered.

At the time EXECUNET(R) went into service, there was no indication from the FCC or AT&T that the service was an invasion of AT&T's public monopoly, MTS. In 1975 AT&T filed a complaint that MCI was invading its MTS monopoly. The FCC accepted the AT&T position and ordered MCI to withdraw the service. MCI filed for a stay of the order with the U.S. Court of Appeals and effectively circumvented the regulatory process. The Court of Appeals granted the stay and held off further judicial process until the FCC could review new arguments in the case. This was a clear attempt by the FCC to try to regain its regulatory initiative. Formal

proceedings lasting until 1976 were conducted by the FCC under Docket 20640. At this time the FCC decided that MCI was not to offer the EXECUNET(R) service. MCI went back to the Court of Appeals, which overturned the FCC decision. In overturning the second FCC decision the court found that the FCC's specialized carrier decision applied only to private line but did not prohibit the offering of an EXECUNET(R) type of service, and that the FCC could not "create competition for competition's sake" and was not "free to propagate monopoly for monopoly's sake."

The court's decision received permanent status when the U.S. Supreme Court denied review in 1978. The Court of Appeals suggested that the FCC had never determined whether the public interest required that AT&T be allowed a monopoly over MTS and WATS. Subsequently the FCC initiated Docket 78-72, which seeks to establish the definition and boundaries of services that must be provided on a monopoly basis. Docket 78-72 proceedings stated that "*de facto* monopoly status exists only because, until the recent past, no one has sought authority to provide MTS," and the FCC decided to determine whether the monopoly status should continue. Meanwhile the FCC allowed AT&T to deny interconnection privileges to all OCCs pending resolution of Docket 78-72. In this instance the FCC was not fostering competition, and it openly defied the court ruling until 1978, when the U.S. Court of Appeals overturned the FCC. This docket has picked up additional matters such as market and separations questions, rate-averaging, economies of scale, and other issues.

Upon AT&T's filing of WATS tariff revisions in 1974, the FCC initiated Docket 19989. A regulatory morass developed, as follows:

- In 1976 the FCC rejected the tariff changes, calling them unjustified.
- A replacement WATS tariff was filed in 1977 and rejected in the same year.
- The FCC allowed the existing WATS tariffs to remain in effect.
- MCI unsuccessfully appealed the FCC decision to allow the existing WATS tariffs to remain in effect.
- The FCC initiated Docket 21402 to determine what differences existed between MTS and WATS. In 1978 the FCC ruled the services to be similar.
- In 1979 AT&T reviewed with the FCC the plans for its new WATS structure.
- In 1979 the FCC initiated Docket 79-154 to solicit comments on AT&T filings of costs and analysis that would support the new WATS tariffs.

4.4.8 Private-Line Services

As a result of the outcome of Docket 20814 (the MPL Inquiry), the FCC determined that AT&T's MPL rates were not lawful. In 1979 the FCC initiated

Docket 79-246, which sought a comprehensive investigation of AT&T's entire private-line rate structure. The new docket includes an examination of various bulk-rate discounts directed at developing "clear and consistent use of rate structures, rate elements and tariff terminology." The events leading to Docket 79-246 are described in the following paragraphs.

Docket 18128 commenced in 1968 when AT&T filed a Telpak service rate increase. Additional private-line rate increases were included as the case continued. The scope of private-line investigations expanded at the same time to include other services. The commission's order in 1976 ruled for FDC methods and found the Telpak rates to be "unjustly discriminatory." Rather than file a new bulk rate, AT&T decided to withdraw its Telpak offering in 1977. A decision by the Court of Appeals allowed the service to continue for existing customers under nonsharing conditions pending further judicial review. This case continues and will have a far-reaching effect on major Government and private business subscribers.

AT&T filed "de-averaged" private-line rates in 1973. This service, called high density-low density (Hi-Low), brought petitions from outside parties and prompted the FCC to initiate Docket 19919. The rates were rejected by the commission in 1976. In response AT&T filed its MPL tariff, which features a declining mileage rate. MPL short-haul rates were much higher and long-haul rates much less than the equivalent Hi-Low rates. In addition, MPL introduced a third mileage rate structure, which was sensitive to connection of a high-density node to a low-density node.

Protests against the MPL filing from competitors and subscribers caused the FCC to initiate Docket 20814 to examine the legality of the new service. It centered on possible anticompetitive issues such as the following:

- High rates for the first mile of service
- High rates for the first 25 miles of service
- Decreases in rates for long-haul circuits

In 1977 the case was enlarged to include proposed revisions to the MPL schedule that would replace Telpak when Telpak was discontinued. In 1978 the FCC divided the inquiry into two phases:

- Phase 1 - the allocation of total costs to the MPL service by means of FDC, Method 7
- Phase 2 - the allocation of costs within the MPL service category and rate structure associated with service pricing

The FCC decision in Docket 20814 was given in 1979. The MPL rates were found to be unlawful and the proceedings were terminated. The current MPL rates were allowed to remain in effect while two more investigations were continued:

- Docket 79-245, which investigates the FDC manual that was being developed in Docket 20814.

- Docket 79-246, a comprehensive rule-making study examining AT&T's entire private-line rate structure

The status of AT&T's de-averaged private-line schedules will depend on the outcome of these two dockets.

4.4.9 Registration and Interconnection

The current issues regarding registration and interconnections are customer interconnection to private lines, registration procedures, and certain other subscriber interconnection issues. Issues and comments are given in Table 4-3 by docket.

In the area of equipment registration, numerous petitions for rule-making are filed with the FCC asking for special consideration or rulings with respect to interconnection, registration, and network protection procedures. Many requests are not handled by dockets, because they are not of far-reaching importance. These requests are handled by the FCC on a continuing basis. Related issues pending before the Commission in 1980 include the following:

- Carrier equipment. Several interconnect entities filed a petition in 1978 to prohibit a carrier from connecting to its network any equipment manufactured by that carrier. The petition also seeks establishment of rules governing general interconnection. Many parties have submitted comments, and the issue is continuing.
- Subscriber interconnection to Dataphone(R) digital service. In 1979 the Independent Data Communications Manufacturers Association (IDCMA) petitioned the FCC to allow subscribers to interconnect their own equipment to DDC; this issue is continuing.

4.4.10 Satellite Services

AT&T currently includes in its rate base investment the Comstar satellite system. This system has been little used: only 10 to 15 percent of available capacity of the first two satellites is producing revenues. As a consequence the FCC initiated the Docket 79-87 inquiry to explore possible removal of the satellite investment from Bell's terrestrial rate base. Even in light of the underutilization of the first two satellites, the launch of a third Comstar satellite was authorized to AT&T and GTE Satellite Corporation (GSAT). Late in 1979 the Commission issued an initial report tentatively concluding that there were not enough data to warrant removal of the Comstar investment from the rate base, since the FCC had imposed a 1976-1979 moratorium on using Comstar for private-line services, because of general economic conditions and other factors. The proceedings are continuing, and possible economic consequences for AT&T are serious.

4.4.11 Shared Use and Resale of Private Lines

In 1974 the FCC initiated an inquiry whose central issue was whether common carrier services could be resold or shared among users. Aeronautical

Table 4-3. REGISTRATION AND INTERCONNECTION OVERVIEW		
Docket and Subject	Date Initiated	Issues and Comments
79-143	June 1979	Issue: Nontelephone company terminal equipment interconnection to private lines and interconnect equipment used on a four-wire basis. Comment: Case is continuing.
19528 Terminal Equipment Registration Program	May 1976	Issue: Nontelephone company equipment interconnected to telephone company public lines. Comment: Common carrier bureau has been conducting meetings to develop interconnect procedures and standards. Proceedings are continuing.
20003 Economic Impact of Competition on the Telecommunications Industry	April 1974	Issue: Broad investigation into effects of competition in terminal equipment and other areas: private-line service, cross-subsidization, and separation procedures. Comment: Docket 20981 separation impact inquiry was initiated. The FCC ruled that competition in the private-line and terminal equipment services is beneficial.
20744	April 1976	Issue: The interconnection of customer wiring, installation, and components. Comment: The FCC liberalized its rules as to who may install equipment or certify wiring. Decision was reached in July 1976.
78-331 Exceptions to Equipment Registration Rules	October 1978	Issue: DoD's and several railroads' objection to AT&T's move to eliminate all exceptions to the registration rules. Comment: The FCC granted the DoD request but denied the railroads' request. Railroads had been historically exempt from Bell equipment interface adapter requirements.
78-36 Primary Instrument Concept	February 1978	Issue: AT&T's primary or main instrument concept, which requires the first telephone on a subscriber's premises to be furnished by the telephone company. Comment: The FCC rejected this concept in June 1978.

Radio, Inc. (ARINC), enjoyed a special status at this time that allowed it to share private-line facilities among the airlines.

The FCC issued its final order in 1976: "Customers who obtain private line services from common carriers should be allowed to share or resell such services without restriction or discrimination." Several parties appealed the order in the U.S. Court of Appeals. In 1978 the FCC decision was upheld, and subsequent appeals to the Supreme Court proved ineffective.

In 1979 MCI submitted a petition to the FCC asking for a rule to permit the shared use and resale of Bell's MTS and WATS. This issue reflects the switched-voice-service equivalent of the question of the shared use of private lines described above. The petition is still under Commission review.

4.4.12 Intrastate Regulation

Intrastate public service or utility commissions (PSCs or PUCs) have basic regulatory control over the following:

- Intrastate MTS
- All exchange-related services
- All terminal equipment, PBXs, and key systems that are not directly used in an interstate service
- Approval and oversight of long-term debt-financing issues
- Quality of service provided by operating companies

The major area affecting interstate services and hence affecting our study is the PSCs' control of local access lines and various types of terminal equipment, PBXs, and key systems.

4.5 TECHNOLOGY FACTORS

As discussed previously, a competitive market has been created by regulatory, judicial, economic, and technological factors. The advances in electronic devices, computers, and the technology of space exploration, and the new regulation of the telecommunications sector have combined to generate innovations that are changing our traditional ways of communicating with one another.

The convergence of computers and communications has already reshaped many traditional institutional forms. The use of technology in private and Government sectors has provided a cadre of mature, sophisticated users whose requirements will be the driving force in future developments.

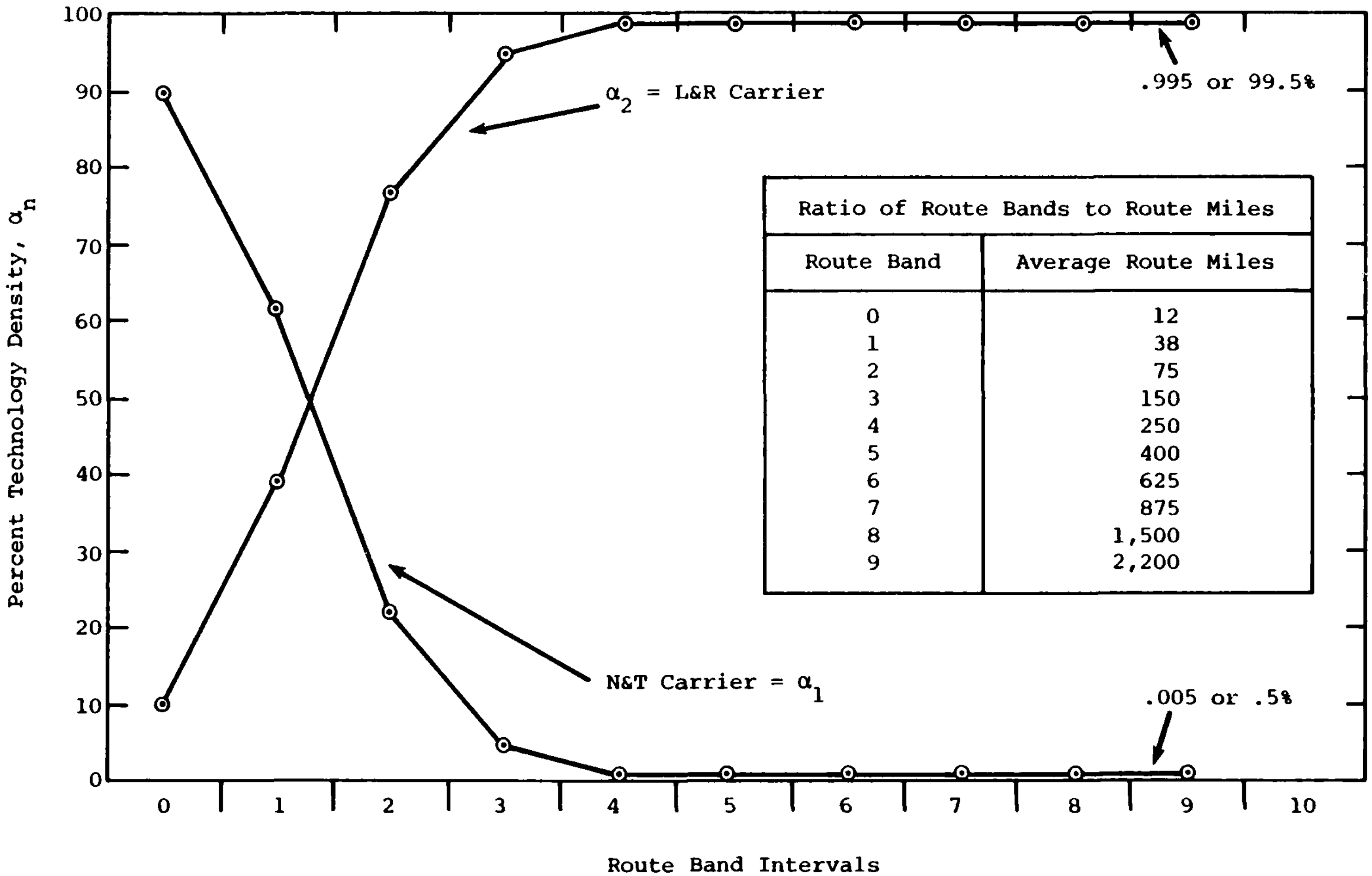
The need for incorporating new technology into interstate carrier services is a result of (1) customer demand; (2) a need for a variety of marketable services; (3) a need for reduction of the costs of maintenance,

operations, and installation; and (4) a need to modernize antiquated facilities. The incorporation of new technology does not necessarily reduce prices paid by the user of services for the following reasons:

- The great bulk of AT&T's old plant may reduce or dilute the effects of more economic or advantageous new technology in the short run. Thus, in areas such as transmission investment reductions per route mile achieved by AT&T's gradual move towards single-side-band radio technology, prices paid by subscribers will not be reduced in the short run and most probably not in the long run. What may become important with this technology is the fact that intergroup 3.0 Mbps digital lines may be carried by the new technology with no sacrifice of interhop spacings and analog circuit capacity.
- Some of the newer technology is much more expensive on a per-unit-cost basis than the older. For instance, old mechanical step-by-step Class 5 offices may be installed at about \$125 (directorized) per line, whereas the newer digital (and electronic) technologies may require an investment of about \$350 to \$500 per line, depending on the line and trunk size of the office. In fact, not only will such increases occur in the installation cost per unit of plant, but there will also be other increases:
    - Depreciation will increase if plant is written off over an equal or somewhat greater life cycle because of the higher book retirement unit cost (RUC).
    - The cost of money for much higher unit costs increases debt and equity-return requirements.
    - Labor costs will rise because of higher skill levels required of craftsmen performing more technical maintenance and operational functions. Automation may halve maintenance and installation labor requirements, thereby reducing annual carrying-charge rates by as much as 12 to 15 percent.

The method selected for handling the mix of new and old technology for this study allows technology to vary as a function of certain parameters such as time, miles, and units in service. For an existing service such as the AT&T MPL service line-haul component, we may have five types of short-haul carrier systems with five different unit costs per mile and long-haul carrier systems using eight different radio technologies. As an example, if there are $U(\alpha_1)$ units of short-haul carriers and $U(\alpha_2)$ units of long-haul carriers in service in a given route band interval (route band intervals are based on route mileage intervals, as depicted in Figure 4-1), we can compute the relative investment density of α_1 technology route miles and α_2 technology route miles for this circuit. Figure 4-1, in Route Band 3, shows the α_2 technology density to be 95 percent and the α_1 technology density to be 5 percent.

The curves in Figure 4-1 derived from actual carrier densities taken from the 1971 AT&T Redcap studies. If the unit cost per route mile for a given technology α_1 is $C(\alpha_1)$ and the unit cost for technology α_2 is $C(\alpha_2)$,



Ratio of Route Bands to Route Miles	
Route Band	Average Route Miles
0	12
1	38
2	75
3	150
4	250
5	400
6	625
7	875
8	1,500
9	2,200

Figure 4-1. RATIO OF L&R AND N&T (TECHNOLOGY) ROUTE MILES TO TOTAL MILES BY ROUTE BANDS

we can calculate the unit investment required for a circuit terminating in any route band. If the circuit length is L, the total line-haul cost, C(L), is $L[\alpha_1 C(\alpha_1) + \alpha_2 C(\alpha_2)]$. We can calculate the line-haul cost for various α_1 and α_2 scenarios by changing the technology density curves of Figure 4-1. We do this by adjusting the curves as given in Figure 4-1 to reflect, say, a heavier use of T-carrier facilities in short- and long-haul application. The mix designed would also reflect the appropriate unit costs associated with each technology. For instance, α_1 short-haul technology costs $30.14 per unit mile and α_2 long-haul technology costs $1.16 per route mile. In our example the Route Band 3 cost mix (when L = 150 miles for an airline Band 3 average) would be

$$C(L) = L[\alpha_1 C(\alpha_1) + \alpha_2 C(\alpha_2)]$$

$$C(L4) = 150 [(.95) (30.14) + (.05) (1.16)]$$

$$= \$4,294.95 + \$7.95$$

$$= \$4,302.90$$

Clearly the overall investment cost is largely influenced by the percentage mix of the more expensive α_1 short-haul technology with the less expensive α_2 long-haul technology. Thus, the infusion of newer technology in the long-haul application will not play as dominant a cost role as the use of less expensive newer types of technology in short-haul transmission facility design. It is also interesting to note that $\alpha_1 = \alpha_2$ at about 57 miles. The most desirable improvement in the transmission technology would occur in the 150-route-miles-or-less facility design and would cause the slope to increase (i.e., the slope from AB[αj to AB[37]), or more realistically, curve the unit cost of α_1 to decrease significantly from $30 per channel.

Similar α-density functions have been developed for the following major classes of facilities:

- Terminals
- Local switching
- Node switching (private line)
- PBXs
- Toll switching
- End-terminal multiplexers
- Intermediate terminal multiplexers
- Digital circuit facilities
- High-density line haul ("A" city to "A" city)
- Medium-density line haul ("A" city to "B" city)
- Low-density line haul ("B" city to "B" city)
- Local distribution facilities

Standard scenarios have been developed that reflect a best-case, a status quo, and a worst-case infusion of technology. It should be noted that the rate of infusion of technology is a careful balance of complex management plans and other forces such as the following:

- Replacement rate of existing plant, i.e., the replacement of old technology with new technology even though the old technology functions as well or only somewhat worse than the newer technology. This is the so-called discretionary portion of a modernization capital budget.
- Modernization of existing plant to meet service levels or to accept new growth. Replacement in this case is justified.
- Plant expansion to accommodate new growth. In this case plant is constructed in the most appropriate technology in order to serve new growth.

Thus, the α-density functions must reflect "real life" migration of technology into service when technology forecasts are set up for study purposes beyond a baseline year.

4.6 ECONOMIC FACTORS

Perhaps the most important factor shaping both the telecommunications marketplace and the cost structures of the telecommunications industry will be the condition of the American economy over the next ten to fifteen years. In this study we need to address the short- and long-term effects of inflation on the cost of doing business in the interstate marketplace. For instance, in a short- and long-term (i.e., 5 and 15 years, respectively) economic-trend scenaric sketching the principal contours of the American economy, we need to answer the question what will be the resultant trend in the cost of providing common interstate carriage? We need to be able to examine the effects of this inflation scenario on the cost structures of the services of each of the carriers being studied in order to ascertain the prospective shifts in cost of service and to examine the sensitivity of cost of service to various levels of inflation rates.

4.6.1 Possible Economic Scenario Outlooks and Rationales

By convention, economists define a recession as an actual reduction in the gross national product (GNP) corrected for inflation ("real" GNP) for two consecutive quarters. If the real GNP remains at less than four percent for two quarters, the experience is described as a "growth recession." The four-percent criterion is a growth rate that allows unemployment to maintain its status quo. In this study we are interested in the potential ranges of inflation over the next five to fifteen years, given postulated scenarios of economic slowdown (recession) or economic expansion. We are not interested in very short-term effects, but in the long-term cost-of-service behavior that persists under the influence of developed economic scenarios. These scenarios are not forecasts or predictions

based on technical forecasts of wages, food, energy, wage-price guidelines, monetary policy, and Government spending, but represent a plausible economic path into the future. No effort is made to invest scenarios with a single cohesive historical thrust; the main effort lies in spanning the possible ranges of outcomes to develop a worst-case economy and a best-case economy and their effects on the cost-of-service structure of the carriers.

In the discussion of inflation, we must bear in mind that economists have designed a number of concepts and measures of inflation for specific uses. For instance, the consumer price index (CPI) is used primarily to measure changes in prices of consumer goods and services. The producer wholesale price indexes measure changes in prices of materials and products at the production or distribution stage of the economic cycle. The most comprehensive measure of inflation is the gross national product (GNP) deflator, which is an indicator of price changes in the economy as a whole. All these indicators are intended to measure changes in prices that have already occurred. Usually an attempt is made to distinguish between the "hard core" or underlying rate of inflation and purely transitory changes in prices of such things as food and energy due to disruptions in supply. Finally, economists have accepted the concept of inflation expectations, which alludes to anticipated price changes. For instance, investors may anticipate a certain return on their capital according to their understanding of (1) the use of their dollars; (2) the potential state of the economy; and (3) regulatory trends, national policy issues, corporation management, and other such matters.

The major cost driver in the telecommunications industry is labor. Wage gains of more than 8 percent have been consistent over the past several years, and when the cost of benefits is added, the annual cost of labor rises to 9.2 or as much as 9.5 percent. Work productivity in this industry, a measure of increase in productive labor output per unit relative to labor input, is about one percent, yielding an effective inflation rate of about 8.5 percent. The foundation of wage gains or prospective wage increases is the ongoing collective-bargaining agreements conducted by the major telecommunications corporations. Labor agreements in other industries (e.g., automobile, electrical and electronic equipment, oil, and trucking) escalate the overall cost of living for the telecommunications work force.

Federal intervention has an important role in controlling the economy. For instance the Carter administration has tried to induce the private sector to restrain rises in wages and prices. In addition, the recent monetary policies of the Federal Reserve Board have raised interest rates above 12 percent on borrowings that used to average 8.5 to 9.0 percent. At times money was not available because of governmental restrictions on lending institution interest rates, which were much lower than returns being paid by other investment instruments.

For our inflation scenarios we have selected three types of economies, which are portrayed in Figure 4-2:

- The expected economy scenario. In this scenario we anticipate that inflation will continue at about 8 to 10 percent per year. Management, the regulators, Congress, presidential policy, labor settlements, and other important factors can adjust to this economy, though the pressure is great. The use of technology is not affected, because there will be market and productivity incentives to use the technology in the provision of services. In fact, serious consideration may be given to increased automation in order to reduce labor requirements. The expected economy is illustrated in Figure 4-2.
- The worst-case scenario. In this scenario (see Figure 4-2) inflation is at 11 percent during the first year, 11.5 percent the second, and 12 percent for the remaining 13 years. Heavy demands in the capital market and the consequent scarcity and high cost of capital will halt significant technological advances. Inflation pressures will be heavy, and carriers will seek frequent rate relief from the FCC. Competition for business will be keen; however, services will not expand at a rapid rate because of the effects of the recession.
- The best-case scenario. In this scenario (see Figure 4-2), a smooth inflation rate of 8 percent is postulated for fifteen years. Substantial improvements in technology will occur, and business will expand.

These scenarios will be used later to show the effects of inflation on costs of individual services for each carrier. In addition, cost sensitivities will be developed for graduated increases (or decreases) in inflation, and appropriate short- and long-term effects on cost will be examined.

4.6.2 Cost of Money and Federal Income Taxes

We can now examine the impact of inflation on debt and equity cost. Again, we are interested in relative effect and possible outcomes for our study. We are not interested in describing structure in detail or in attempting to "crystal ball" the financial state of the telecommunications business. We would like to develop plausible cost-of-money scenarios for the work at hand. Two types of capital determine the cost of money:

- Debt - short-term and long-term borrowings
- Equity - common and preferred stocks

During the first eight months of 1978, U.S. corporations raised \$29.2 billion in the securities markets. Of this amount, \$22.8 billion consisted of nonconvertible bonds (i.e., bonds that may not be converted to shares of stock), \$1.9 billion consisted of preferred stock, \$4.3 billion consisted of common shares, and \$0.2 billion consisted of convertible bonds.

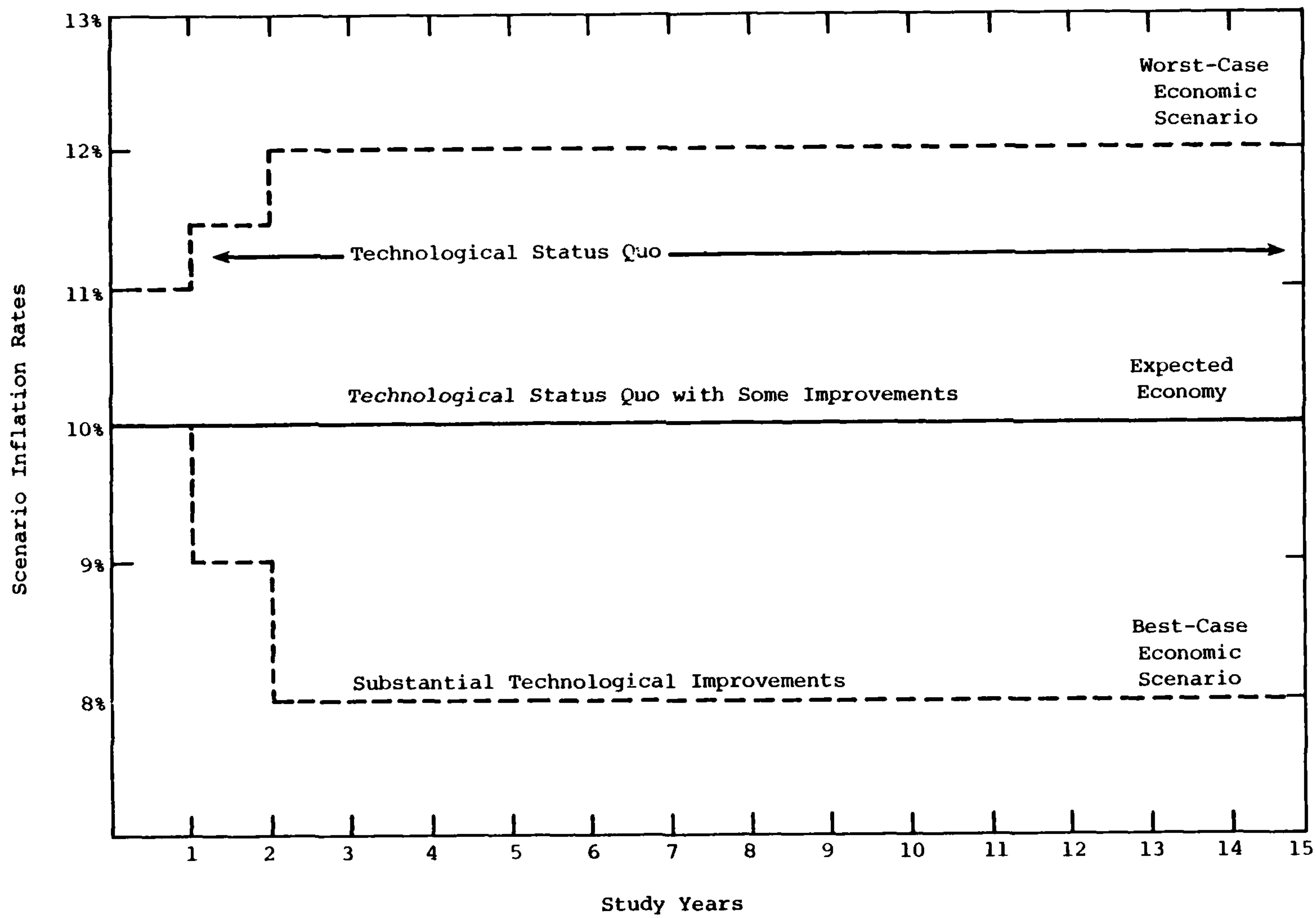


Figure 4-2. ECONOMIC SCENARIOS

Communications corporations floated $2.1 billion, or 7.3 percent, during these eight months. It is expected that the capital demand expectation will maintain about the same percentage share. The cost of obtaining capital is related to such factors as demand, the outlook for inflation, the investor's perception of risk in the given business sector, the investment activity of sectors that hold securities, and other factors. In general, severe inflationary pressures and dollar weakness in the international foreign exchange market's availability of investable funds will cause higher interest rates on borrowings and expectations of a higher return on equity. In more favorable times, when there is little inflationary pressure, interest rates on borrowings and return rates on equity will be reduced.

Our approach was, first, to hypothesize a fixed rate of return and a fixed federal income tax factor and, second, to hypothesize a variable rate of return and a variable federal income tax rate based upon forecasts of the relative contribution of inflation to debt and equity costs.

The following is the general expression for the combined rate of return and federal income tax factor, $\Phi(n)$, to be multiplied by net book (book cost of plant less accrued depreciation reserves) in order to calculate the annual cost of money and federal income taxes:

$$\Phi(n) = \left[D_r \; [I_d + \alpha_1 \; (a + 1)^n] + \frac{1 - D_r}{1 - ETR} \; [ROE + \alpha_2 \; (a + 1)^n]\right]$$

where

D_r = ratio of total debt to total debt and equity at cost

I_d = weighted debt interest rate, or embedded cost of debt

α_1 = expected fraction of contribution of inflation to the embedded cost of debt

$$a = \left[\left(\frac{15}{I_{fo}} \frac{DI}{dn}\right) \; 1/15 - 1\right]$$

where

$\frac{DI}{dn}$ = expected rate of change of inflation over a study period

I_{fo} = baseline inflation rate

n = study year

ETR = effective federal tax rate

ROE = return on equity

α_2 = expected fraction of contribution of inflation to the cost of equity

In addition to the above expression, we chose to allow $\Phi(n)$ to be driven by a 15-year data base scenario that allows D_r, I_d, ROE, and ETR to be varied as a function of study year in order to generate return and federal income tax scenarios.

4.6.3 Depreciation

Where depreciation calculations are required, straight-line rates are developed by class of plant from AT&T engineering economy literature or from exhibits and work papers filed with local PSCs or the FCC. For newer equipments, straight-line rates are taken over life-cycle periods considered justified for capital recovery.

4.6.4 Indirect Economic Factors

Where factors such as loss of contribution support occur (e.g., the loss of toll revenue support of local access line rates), adjustments are postulated on the basis of our review of filings with the FCC and various PSCs. Cross-elasticities are also determined by the same method or hypothesized at reasonable levels. Where these factors are used, the background or judgment will be noted.

4.7 STANDARD SCENARIOS

A substantial data base has been developed that contains standard scenarios for the following:

- Technology by type and element of facility
- Technology as a function of a variable such as terminal density in a route band or technology in a route band
- Inflation rates. Scenarios include the following:
  - The standard inflation scenario
  - Effect of expected inflation rate on acquisition cost of new-technology equipments
  - Effect of expected inflation rate on old-technology equipment maintenance costs
  - Inflation rates associated with the cost of money and federal income tax algorithm
- Unit costs by technology type
- Normalization factors for various vintages of cost components, in order to normalize all unit costs to the start of the first study year

These scenarios will serve as the basis for the CTC-PAM cost trend computations. A compilation of the CTC-PAM data base is presented in Appendix B, together with a description of service building blocks and associated cost elements.

CHAPTER FIVE

COMMERCIAL TELECOMMUNICATIONS COST PREDICTION AND ASSESSMENT MODEL (CTC-PAM)

In Chapter Four we discussed the major factors that affect common carrier offerings. In this chapter we will discuss the mechanism for establishing trends in common carrier offerings: the commercial telecommunications cost prediction and assessment model (CTC-PAM). We developed this model to use the technology and cost-related factors described earlier in establishing cost trends for common carrier services.

5.1 SELECTION OF A FORECASTING VEHICLE

Bearing in mind the project objectives and the characteristics of the common carrier data available for analysis, we concluded that a cost model method of predicting cost trends needs to show the following:

- Inflationary effects on labor-related operating expenses
- Inflationary effects on the capital unit cost of service facilities
- Inflationary effects on labor related to the installation of investments
- Inflationary effects on capital-related costs
- The changing technology mix due to (1) the infusion of new technology and (2) the use of differing technologies as a function of transmission distance

We selected an engineering cost model approach that allowed capital structure (e.g., return on equity, embedded debt cost), operating expense (e.g., maintenance), technology (e.g., microwave radio, carrier systems), and other factors to be generically defined in a data base used by a number of specialized service-cost-synthesis algorithms. After service costs have been specified, specialized cost-prediction algorithms are used to predict cost trends as a function of known baseline service costs, technology, rate of return, and federal income tax and inflation scenarios. The standard approach of forecasting future trends uses multiple linear regression and other mathematical techniques to develop mathematical functions representing service costs as a function of variables such as time, inflation, labor hours, use of technology, and cost. Our analysis of the available data showed that most of the cost structures of the industry were

homogeneous in terms of various cost attributes; however, the ambiguities of the process of cost allocation, insufficient historical study data, and other problems suggested that an engineering cost model constructed at a given time (point model) would provide the most efficient method of extrapolating service costs into the future.

5.2 OBJECTIVES OF THE CTC-PAM

The objectives formulated for the computer-based model were as follows:

- The model must assess cost trends for various services provided by the interstate carrier industry.
- It must allow a synthesis of proposed interstate services, using a mixture of generic AT&T or OCC cost elements, in order to make possible the study of proposed or emerging services.
- It must allow the determination of the relevant factors' impact on service cost structures in order to permit trend analysis.
- It must interact with the user and require a minimum of user sophistication for the handling of complex cost studies.
- It must be flexible enough to allow expansion of services to be studied.
- It must allow the performance of specialized studies such as sensitivity studies and analysis of cost-of-service cost components (e.g., line haul, end or intermediate terminal multiplexer costs, terminals, and local distribution).

In the formulation of the objectives for the CTC-PAM, particular care was taken to ensure that trends were analyzed for the most general cost structures as well as for some specialized structures that require interpolation of density function, cost, and distance.

5.3 APPROACH TO PREDICTING COST TRENDS

The approach to predicting cost trends of the various carrier services is based on a "building block concept." That is, each of the services examined (e.g., AT&T's MPL offering) comprises a set of equipment cost elements (building blocks):

- Terminals
- Local access lines
- Exchange trunks
- Local and toll switching
- Intercity line haul
- Intermediate and end terminal multiplex

Figure 5-1 illustrates the building block approach as applied to the costing of AT&T's MPL service. As indicated, the MPL service consists of 14 building blocks (counting the mirror-image units) and each building block must be costed (depending on its mix of technologies) in terms of (1) embedded and current costs for facilities and labor and (2) the operating expense associated with maintenance, inflation, and investment carrying charges. Figure 5-1 shows that the costs of certain building blocks in the MPL service are a function of the three MPL schedules related to connecting city densities.

To determine future trends for the services under analysis, we modified the costs developed above (using certain scenarios) to account for certain rates of technology infusion, inflation, and estimates of federal income tax and rate of return.

A general description of the CTC-PAM follows.

5.4 GENERAL CTC-PAM ARCHITECTURE

This section of the report describes the CTC-PAM. More specific details concerning the description and operation of the model are presented in Appendix A.

The architecture of the CTC-PAM consists of a main program and 23 subroutines and, as illustrated in Figure 5-2, is functionally organized into the following four major components:

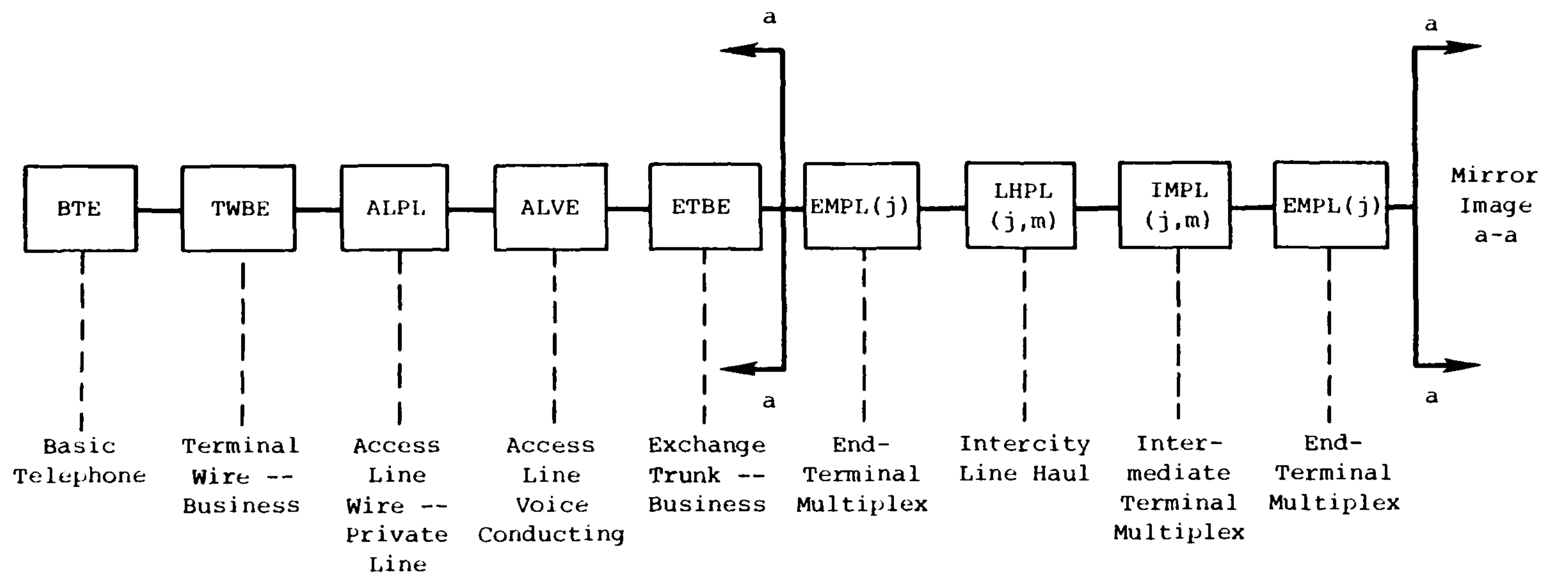
- Input interface
- Central logic
- Data base
- Report generator

The main program is part of the central logic; it controls the input interface, data base, trend computation, and presentation of results. Responding to user requests, the main program determines which combination of the 23 subroutines will be exercised to make the trend computations. The four CTC-PAM components are discussed below.

5.4.1 Input Interface

The input interface component solicits user input to describe the particular trend to be analyzed. The input interface is highly interactive, prompting the user to supply analysis parameters such as the following:

- Service selection from 22 service offerings of AT&T, Western Union, MCI, SPCC, and RCA
- Service dimensions. Having selected a service, the user must supply certain key parameters, such as length of service in miles, number



When j = 1, it represents MPL Schedule I.

When j = 2, it represents MPL Schedule II.

When j = 3, it represents MPL Schedule III.

m = Mileage

Figure 5-1. BUILDING-BLOCK APPROACH TO COSTING AT&T'S MPL SERVICE

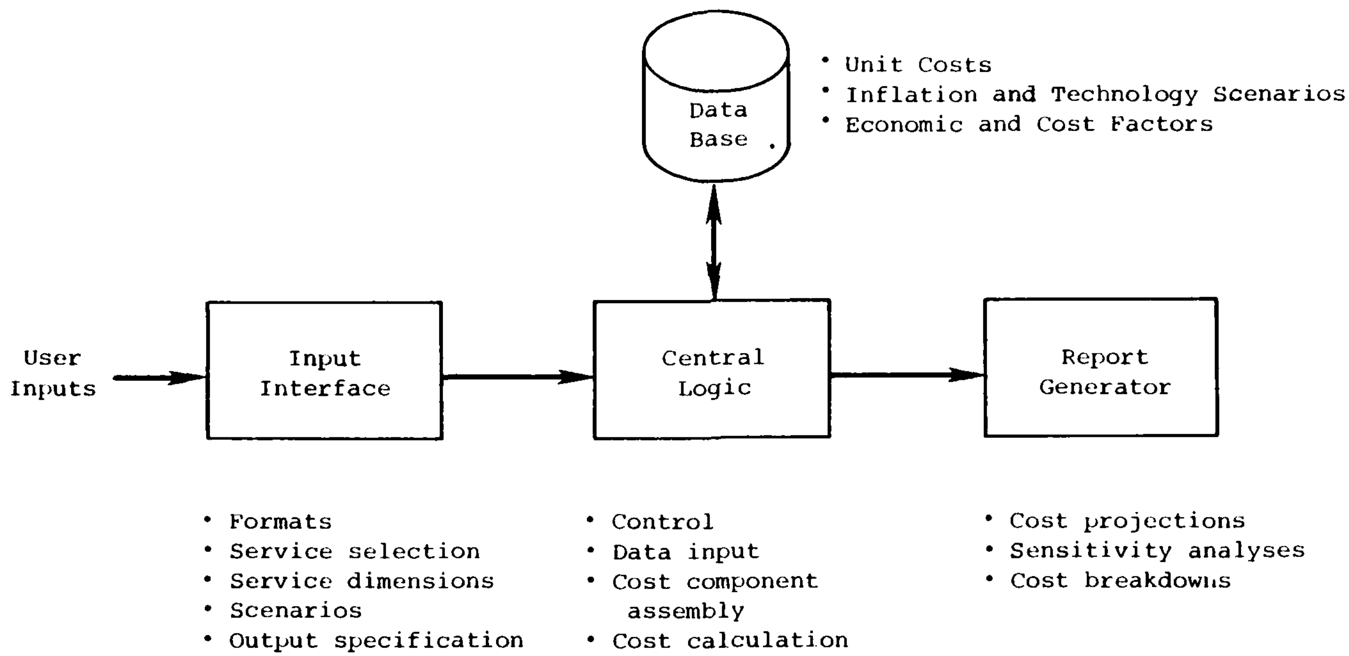


Figure 5-2. CTC-PAM FUNCTIONAL FLOW

and type of end-terminals, number of trunks and lines for a switched offering, and call duration for measured-use services.

- Study years. User enters prediction year for single-year analysis and number and interval of iterations for multiyear analysis.
- Scenario definition. If user wants to examine inflation and federal income tax and rate-of-return scenarios that differ from a baseline case, resident in the program, data are called for.

In addition to these analysis parameters, the user can choose (through the input interface) whether the report will give detailed or summary cost figures.

5.4.2 Central Logic

The central logic consists of the following four major elements:

- Control. Controls the input interface, data base, other program logic, and report generator. As mentioned earlier, this is the main program of the model.
- Data Input. Calls data out of the data base to provide cost basis for the various building blocks (cost elements) of each service and calculates and saves the federal income tax and rate-of-return factors for later use.
- Cost Component Assembly. Assembles the data extracted in the data input element and controls the flow of these data to the cost calculator.
- Cost Calculations. Performs all the cost calculations necessary for predicting trends for the various services.

5.4.3 Data Base

The CTC-PAM data base has approximately 16,000 elements of cost-related data such as embedded unit costs (for labor and equipment), net book ratios, monthly carrying charge rates for non-capital-related costs, capital-related costs, baseline inflation rates for equipment, operating costs, and current-to-embedded cost ratios (refer to Appendix B).

5.4.4 Report Generator

The report generator displays the cost-calculation results at one of two user-selected levels of detail: cost summaries or breakdown of cost details.

5.4.5 CTC-PAM Prediction Algorithms

The CTC-PAM performs its predictions in three distinct steps.

5.4.5.1 Step 1

According to the user's identification of the service to be studied, service dimensions, study years, and scenario definitions, the model calls out and assembles basic cost elements (building blocks) from the data base. For instance, if the user specifies a business exchange access service, the model will assemble the following information:

Name of Service: Business Exchange Access Line with a Key Telephone Set

Cost Element	Number of Units	CTC-PAM Cost Code
Terminal or business key set	1	KTE or BTE
Terminal installation inside wire (business)	1	TWBE
Access line cable pair (business)	1	ALBE
Access line voice (business)	1	ALVE
Exchange trunk (business)	1	ETBE
Local switching (business)	1	LSBE

Each cost element has an associated 13-variable cost vector in the CTC-PAM data base containing the following:

- Three inflation rates associated with equipment-embedded unit cost, installation labor, and labor costs of maintenance and testing (I_{CC}, I_{CL}, and I_R, respectively)
- Unit book labor cost for the service element (B_{CF})
- Unit book labor cost of installation for the service element (B_{CL})
- The monthly cost of operation (comprising maintenance, administrative and general office salaries, testing, and various overhead costs) (B_R)
- The amount of monthly operating expense required per unit of service (Z_R)
- A current-cost capital-related carrying charge, which includes ad valorem taxes and depreciation (F_C)
- An embedded-cost capital-related carrying charge, which includes ad valorem taxes and depreciation (F_E)
- Current-to-embedded cost ratio for the cost element C_E
- Net book ratio for current cost element (NB_C)
- Net book ratio for embedded cost element (NB_E)
- The year in which the cost data were developed (N)

The cost elements are then used to request a related 13-element cost vector from the CTC-PAM data base. After the cost vectors are received, each vector is passed to an appropriate prediction subroutine to be used as described in Step 2.

5.4.5.2 Step 2

Using baseline scenario inflation rates for installation costs, labor costs, and capital-related costs, and a standard federal income tax and rate-of-return scenario, the model translates the data assembled in Step 1 to the baseline year of 1980. For example, a given cost vector may contain data that are two years old; the model will calculate the 1980 values for the cost vector.

5.4.5.3 Step 3

Next, the cost vectors acted upon in Step 2 are used by prediction algorithms to trend costs up to 15 years into the future, given standard scenarios for technology, inflation, federal income taxes, and rate of return. In addition, the prediction algorithms are designed to accept various changes in rates of inflation and federal income taxes and rate-of-return scenarios in order to determine resultant effects on cost trends. Predictions are performed for all elements of cost (six elements for the above example) and accumulated in order to predict the total monthly cost trend of the service under study for the years of study specified by the user.

5.4.6 CTC-PAM Capabilities

The CTC-PAM is relatively simple to use. Its interface teaches the user by interacting with him. In its present configuration, the CTC-PAM is capable of analyzing cost trends for existing AT&T and OCC services. In addition, the model can be expanded to analyze other service cost trends. This capability is discussed in Chapter Seven.

As stated earlier, more detailed information concerning the description and operation of the model is contained in Appendix A.

5.5 EXAMPLES OF THE USE OF THE CTC-PAM

We illustrated in Section 5.4.5 the facility and basic cost elements that must be combined physically and algebraically to provide a local business exchange access line service. This service would normally appear on a key telephone system or a PBX as a telephone company trunk. Though the service appears to be simply composed of six cost elements, the actual computations for the service require the cost analysis of four types of plant transmission technologies, three types of trunk technologies, and three types of Class 5 end-office switching technologies, since these technologies form the mix of facilities now in use. In addition, each technology is forecasted over a 15-year period, in terms of relative density or mix, in order to specify the infusion of technology. Further,

the following inflation rates are specified for each cost element (including each type of technology): inflation for new equipment facilities, inflation for labor associated with equipment facility installation, and inflation associated with labor and other variable costs of operation.

A typical study might be to determine the expected cost per month for a business access line service over a 15-year interval using baseline inflation rates and the industry trends in modernizing the technology of central office switching facilities. Then one might want to determine the effects of more rapid modernization of switching equipment using new switching technologies. In this example we will illustrate the ease of exercising the CTC-PAM to determine cost trends for the baseline study and will then establish a technology scenario to determine the effects of new technology on our example of a business access line service.

Figure 5-3 depicts the input of eight specifications for our example as prompted by the CTC-PAM. The study in question will require the model to produce cost trends as follows:

- The first study year will be 1980.
- The CTC-PAM is requested to produce 14 iterations with one-year intervals, which will give a 1980-1994 (15-year) forecast.
- The user has chosen not to add or subtract baseline inflation scenario rates to produce an alternative study scenario.
- The user has chosen to use the baseline federal income tax scenario.
- The user has declined a detailed cost breakdown of the trend analysis.
- The user has requested one terminal.
- The user has requested a basic set.
- The user has requested a business class of service.

Two years of the 15-year CTC-PAM output are summarized in Figure 5-3. The first output in this figure (1980 results) is interpreted as follows:

- The study year is 1980.
- The prediction is for exchange service.
- Delta inflation is all zero (baseline case assumed).
- The federal income tax and return-on-investment (FIT/ROI Rate) factor is .017392.
- Service cost components are presented horizontally for each facility element, as follows:

Cost Component	Definition
X_{CC}	Forecasted current facility capital cost (book cost)
X_{CE}	Projected embedded facility capital cost (book cost)

```
  ENTER SERVICE DESIRED (1-18, 0 FOR MENU)
? 1
? ENTER PREDICTION YEAR (1980 - 1994)

  ENTER NUMBER OF ITERATIONS AND DELTA-YEAR
   IN THE FORM (2,5) - ENTER (1,0) FOR SINGLE RUN
? 2,5

  HOW MANY DELTA-INFLATION FACTORS DO YOU WANT (0-5)?
? 0

  DO YOU WANT TO INPUT A FEDERAL INCOME TAX
   AND RATE OF RETURN SENARIO? (Y OR N)
? N

  DO YOU WANT DETAILED COST SUBTOTALS? (Y OR N)
? N

 ENTER NUMBER OF TERMINALS(0 - 1)
? 1

 ENTER TYPE OF TERMINAL
 1- BASIC SET
 2- KEY SET
? 1

 ENTER CLASS OF SERVICE
 1- RESIDENCE
 2- BUSINESS
? 2


 PREDICTION FOR EXCHANGE                    YEAR-1980
 DELTA-INFLATION- 0.000 0.000 0.000         FIT/ROR RATE-   .017392
 COMPONENT            XCC          XCE          YCC          YCE          XE

TERMINAL             51.39        39.42        45.50        34.06        1.79
LOC ACCESS          746.04       376.00       564.19       285.44        8.67
LOC SWITCH          465.50       296.90       320.52       198.66       10.76
EXCH TRUNK          263.62       129.76       210.44       103.54        2.73
TOTAL COST         1526.54       832.07      1140.64       621.69       23.95


 PREDICTION FOR EXCHANGE                    YEAR-1985
 DELTA-INFLATION- 0.000 0.000 0.000         FIT/ROR RATE-   .018267
 COMPONENT            XCC          XCE          YCC          YCE          XE

TERMINAL             67.81        51.54        60.55        44.94        2.48
LOC ACCESS         1018.97       518.12       775.60       395.85       12.92
LOC SWITCH          494.83       398.06       351.88       284.16       17.63
EXCH TRUNK          334.50       165.59       266.64       131.91        3.76
TOTAL COST         1916.11      1133.32      1454.67       856.86       36.78
```

Figure 5-3. EXAMPLE OF BUSINESS ACCESS LINE

Cost Component	Definition
Y_{CC}	Projected current facility net capital cost (net current book)
Y_{CE}	Projected embedded facility net capital cost (net embedded book)
X_E	Predicted monthly cost of service

In our example the total monthly cost (XE) for business access lines is $23.95 for 1980. Figure 5-4 summarizes the baseline total monthly expenses predicted for this service over a 15-year period. In addition, the 1994 monthly expense is noted in the figure for increases in inflation rate (over an average baseline 8 percent value) of 1 percent, 2 percent, and 3 percent. As illustrated, the 1994 monthly costs for these increases are $84.03, $98.12, and $114.41. These three inflation changes produce increases of 16.9 percent, 36.5 percent, and 59.2 percent, respectively, over the 15-year period. This yields for our particular example sensitivity factors of 16.9%/1% = 16.9, 36.5%/2% = 18.25, and 59.2%/3% = 19.7, which may be used to calculate 15-year effects of any movement in the cost of service, such as an increased labor settlement or allowed rate of return.

An important element of the CTC-PAM is the various technology scenarios used in studying cost trends. Figure 5-5 depicts a typical local switching scenario for two cases related to the business line example discussed above:

- Baseline (or gradual) technology scenario for phasing out step-by-step and crossbar switching technologies and phasing in electronic and digital switching technologies
- Advanced modernization (rapid) technology scenario for phasing out step-by-step and crossbar switching technologies and phasing in electronic and digital switching technologies

The first scenario (as depicted in Figure 5-5) is the expected baseline trend for the three local switching technologies included in the CTC-PAM data base. Step-by-step is phased out in seven or eight years, and crossbar is gradually reduced from 73 percent to 24 percent of the technology mix over the 15-year period. In addition, the new digital and electronic technology is phased in completely (in a linear fashion) over the period. This scenario represents an orderly transition, which reflects the historical rate of change of technology mix in the Bell system.

The second scenario (as depicted in Figure 5-5) represents a management decision to phase out switching in the following fashion:

- Step-by-step technology is phased out by 1984 because of its inability to provide the high-demand custom calling features in this type of technology. In addition, maintenance costs are high for step-by-step.

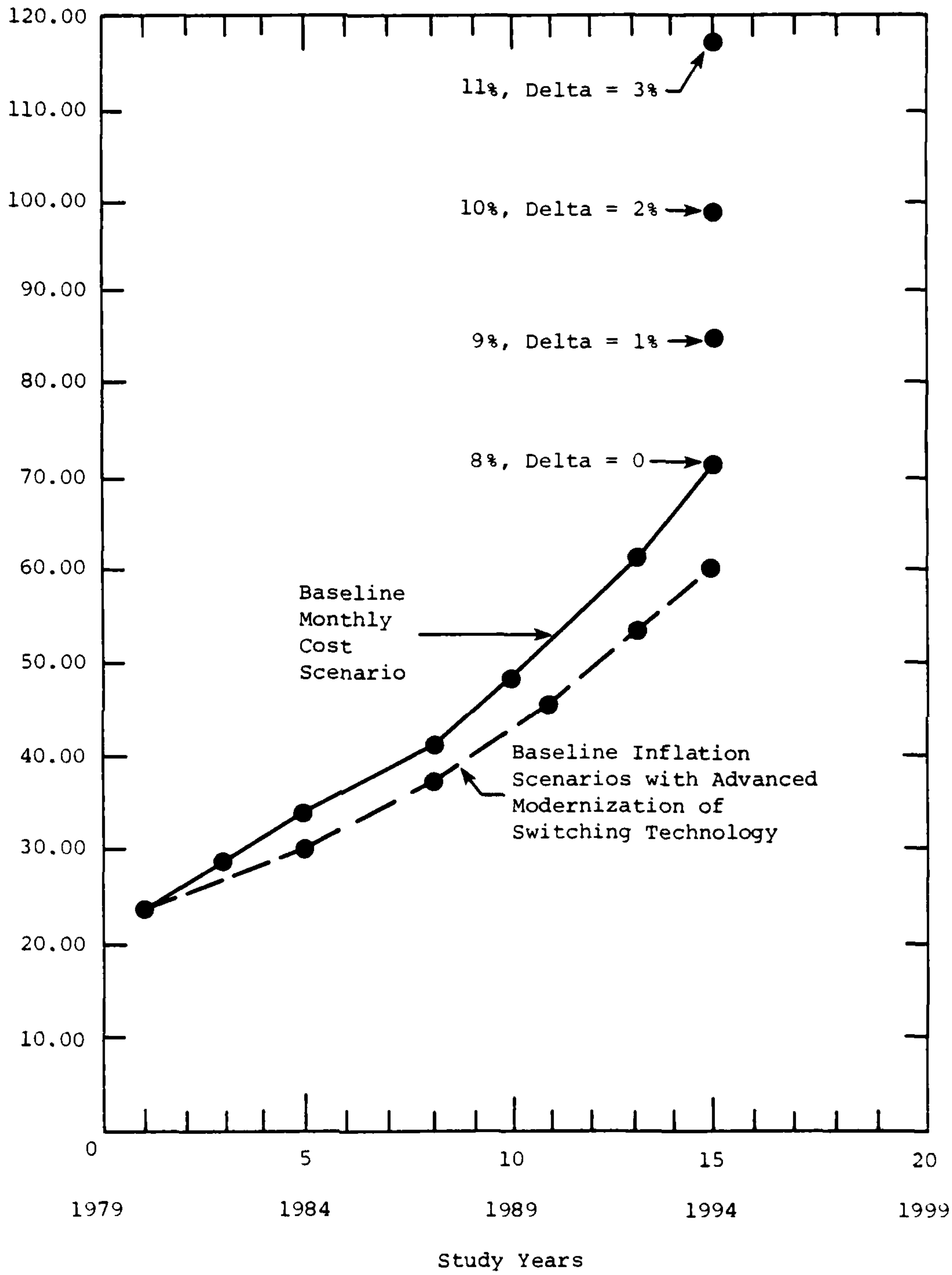


Figure 5-4. EXAMPLE OF CTC-PAM MONTHLY SERVICE COST TREND FOR LOCAL BUSINESS ACCESS LINE

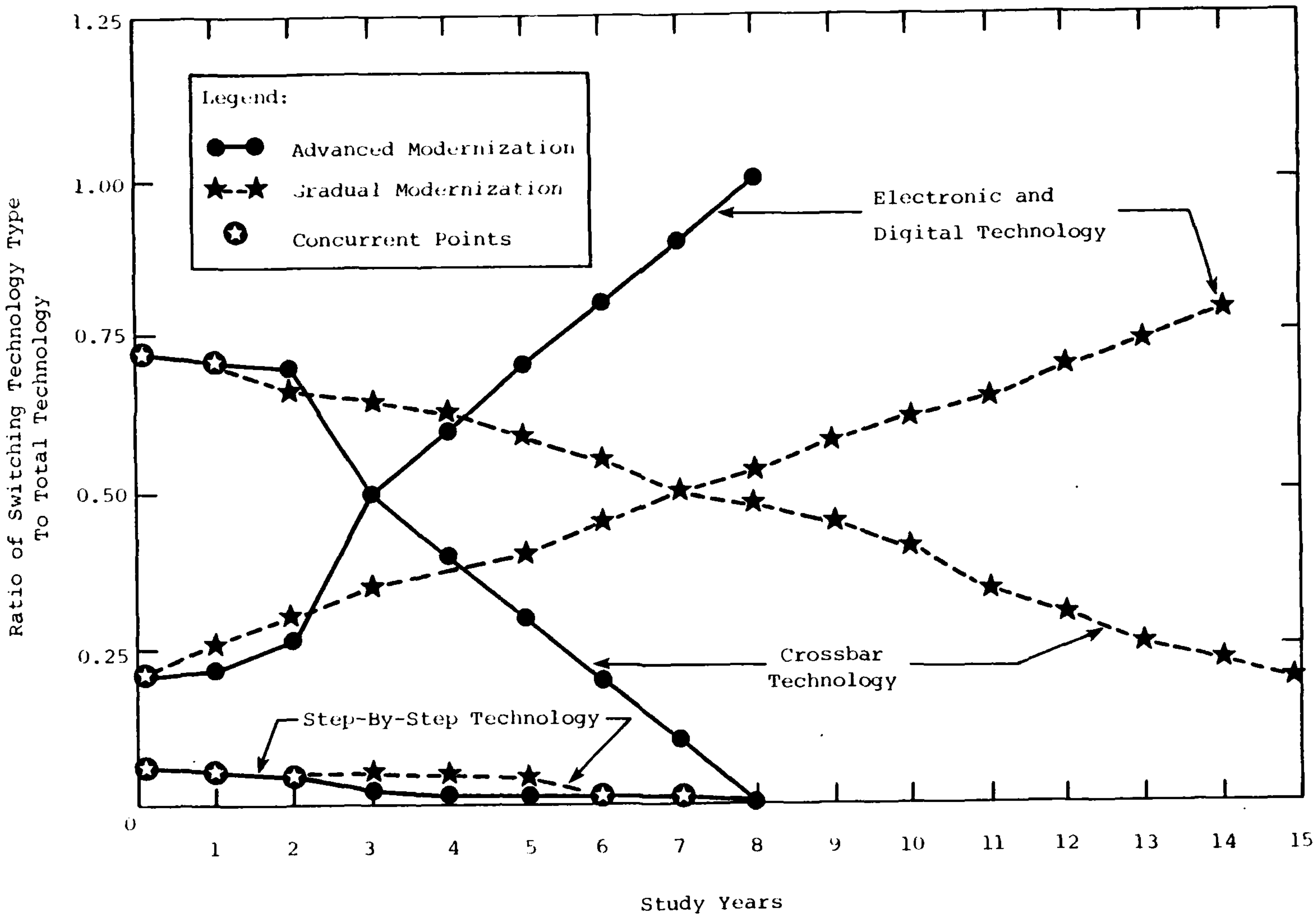


Figure 5-5. EXAMPLE OF SWITCHING TECHNOLOGY SCENARIOS FOR BUSINESS ACCESS LINE

- Crossbar technology is phased out of service by 1989 or 1990, also reflecting customer pressure for custom calling features, a need for reduced maintenance activity, and management's decision to advance the modernization program.
- Electronic and digital switching centers are installed at a rapid rate to take advantage of (1) maintenance cost reductions due to remote maintenance capability of central offices, (2) custom calling features demanded by subscribers, and (3) substantial T1-carrier savings realized by modernizing carrier plant to obtain channel equipment savings on each digital switch end. An anticipated work productivity gain of 3 percent is included in the scenario.

The saving in 1994 (brought about by the advanced modernization scenario) is about 15 percent of the baseline scenario monthly cost. This saving, with a 3 percent increase over the baseline inflation scenario, produces a net saving of about 54.5 percent if management's advanced modernization scheme is able to maintain its productivity gain.

A feature of the CTC-PAM that is useful in studying similar carrier services is that it can be used to forecast trends in a new service category by combining elements of services existing in the data base (e.g., AT&T local access plus a WU satellite circuit). Then the trends are used to develop indexes of the service for expected, worst-case, and best-case scenarios of interest. These indexes may then be used to factor rates of a similar service offered by another common carrier for which no data may be available. This type of index development is shown in Table 5-1.

The indexes developed in Table 5-1 would be multiplied by the service rate of the other carriers' new or existing service. For instance, if the other carrier were to offer a business access line rate of $21.00 in 1980, the cost prediction for this service in 1994 would give $21.00 × 3.0000 = $63.00. The same set of indexes may also be calculated for a service with all new technology (as is the case with the OCCs) by developing the appropriate technology scenario and exercising the model.

Table 5-1. DEVELOPMENT OF COST-PREDICTION INDEX FOR LOCAL BUSINESS ACCESS LINES WITH THE BASELINE SCENARIO		
Study Year	CTC-PAM Monthly Cost Trend (Dollars)	Business Access Line Index (Cost = $23.95)
1980	23.95	1.0000 (base year)
1981	25.93	1.0827
1982	28.09	1.1695
1983	30.34	1.2668
1984	33.52	1.3996
1985	36.19	1.5111
1986	39.10	1.6326
1987	42.19	1.7616
1988	45.55	1.9019
1989	49.18	2.0534
1990	53.05	2.2150
1991	57.22	2.3891
1992	61.79	2.5800
1993	66.64	2.7825
1994	71.86	3.0000

CHAPTER SIX

FORECASTS OF TRENDS IN CONUS COMMON CARRIER SERVICE OFFERINGS

In Chapter Five we described the CTC-PAM model in terms of its salient design characteristics and general study capabilities. In this chapter we will describe the general methodology used to forecast trends in CONUS common carrier offerings for major interstate services and will analyze the major services offered by the six carriers under study. In addition, we will present cost trends in leased PBXs, tandem switching facilities, and earth terminals.

6.1 GENERAL METHODOLOGY USED TO DETERMINE FORECASTS AND TRENDS

The cost functions associated with interstate services are, generally speaking, complex. The responses of these cost functions to changes in inflation, technology, and other financial parameters were determined by trial runs of the CTC-PAM model. In many instances, sensitivity to various parameters were tested, and relative ratios of percentage change in a given factor or component of cost to total monthly costs were recorded, to examine the vulnerability of the cost of service to certain factor changes.

Various scenarios for inflation, technology, and rate of return were entered into the model data base to determine 5- to 7-year and 15-year (short-term and long-term) trends in service costs for major service categories. These cost trends were then converted into rate-forecasting indices in the same manner as described in Section 5.5 for the example of the local business access line. Indices were developed by dividing the 1980 service costs into the future costs predicted by the model, to determine a ratio of future costs to 1980 predicted costs. These indices could then be used to scale present service rates into the future for the services considered in this report as well as for any other existing tariff. Indices were developed for factor, technology, and financial changes associated with study scenarios, and service rates were rescaled to show short-term and long-term trends in rates. This methodology of scaling existing tariff rates into indices permits an "apples-to-apples" comparison of new service rate trends with existing baseline rates. These indices are also useful in the forecasting of trends in services that use equivalent facilities (e.g., Western Union offers Telpak as a concurring carrier and will use similar AT&T facilities). Scenarios developed in this fashion reflect worst-case and best-case assumptions

about timing, unit cost changes, inflation rates, and technology changes. Certain services may be discontinued or drastically restructured by the following:

- An FCC or court declaration that the service is unlawful (e.g., Telpak)
- FCC findings (e.g., predatory pricing and excessive rate of return)
- Company withdrawal of the service tariff due to lack of demand, or a forced migration of subscribers to another, similar service

Where significant changes are expected for the services under study, the changes will be mentioned and possible effects on rates and tariff form will be described both qualitatively and quantitatively.

We distinguish between actual tariffed rates and cost trends developed by the CTC-PAM. The arrangement of the various tariffed rates is the "tariff form," a term meaning that various service elements may be priced on a marketing or value-of-service basis; e.g., businesses may be required to pay more for local service than residential subscribers. In addition, some services may be priced on a "lumped" monthly rate basis (traditionally called "umbrella" pricing) by one carrier, and the price may be broken down into elements of service by another. Another example of form is "bulk" buying or leasing, for example, the Telpak tariff, which allows a customer to purchase 60 (Type C) or 240 (Type D) voice-grade circuits at a discount price instead of leasing the same number of discrete voice-grade circuits. In any case, costs recovered by the pricing methodology (tariff form) may vary between carriers. The CTC-PAM focuses on costs and not tariff form.

The OCCs have a discount plan based on the number of channels and terminals leased by the customer. The discounts, attractive to both the company and the customer, have the following benefits:

- The OCC attracts more business.
- Customers get a larger discount as their network grows in size.
- Customers become accustomed to discounts and therefore achieve the satisfaction of being a part of the carrier's business and not just rate-payers.
- The OCC can sell the customer other services that would not be attractive or even noticed otherwise. For instance, an SPCC private-line customer might also subscribe to the WATS-like SPRINT service because he has confidence in SPCC and good relations with the account manager and may be convinced of the price advantage.

6.2 FORECAST RESULTS

Having described the general approach to developing forecasts of trends in service offerings, we now give the results of these analyses for 19 services offered by the six carriers under study. Cost trends for PBXs, tandem switches, and satellite terminals are also included.

Note that the tariff rates illustrated herein are these that were effective during the writing of this report; i.e., June 1980. Activity associated with rate and tariff changes filed with the FCC subsequent to this date may present a noticeable variance to the reader.

6.2.1 Trends in AT&T Service Offerings

The following major AT&T tariff areas were examined in this study:

- Multischedule Private-Line Service (MPL), a discrete-channel, full-period voice and data transmission service
- Telpak, a wide-band bulk transmission service
- Dataphone Digital Service (DDS), an all-digital transmission service
- AT&T wide-area telecommunications service (WATS), an interstate, switched, voice-grade offering providing service at a bulk-use rate
- Local distribution, which connects a subscriber's station or terminal with Bell facilities or an OCC's facilities, which are usually provided by Bell
- Common Control Switching Arrangement (CCSA), which allows a user to build a switched private-line network
- Enhanced Private Switched Communication Service (EPSCS), which allows a user to build a switched private-line network (The EPSCS service is provided by an ESS machine that allows enhanced network features not offered by the CCSA.)

The following subsections present the trend analysis results for these seven AT&T offerings.

6.2.1.1 Trends in AT&T's Multischedule Private-Line Costs

As discussed earlier, the present Multischedule Private Line (MPL) tariff allows AT&T to have a differential rate structure recognizing that facilities can be built and operated at low cost along heavy traffic routes (e.g., New York City to Chicago). This cost differential allowed AT&T to de-average its private-line rate structure and charge lower rates for high-density routes and higher rates for low-density routes. The MPL tariff filed in 1977 replaced a de-averaged tariff, filed earlier, known as the "Hi-Low" tariff. After the 1977 filing, AT&T filed a new MPL tariff to replace the present tariff in event of the removal of Telpak, which was declared unlawful by the FCC. The revisions to the present MPL tariff reflected rates generally lower than the present schedules, but the tariff has not gone into effect, because the U.S. Court of Appeals has interceded.

As stated earlier in this report, the FCC (in Docket 20814) declared MPL rates to be unlawful. The FCC decided to terminate that inquiry and launch a comprehensive investigation of AT&T's private-line structure by initiating the FCC rule-making proceedings -- Docket 79-246. In terminating the inquiry, the FCC noted that the MPL pricing structure provided higher charges for services for circuits less than 25 miles in length than the

former Hi-Low tariff and that the first mile had an unduly high charge: $51.00, $52.00, and $53.00 per month, respectively, for Schedules I, II, and III.

Given these uncertainties surrounding the MPL tariff, our analysis of this tariff should include an investigation of alternative rate structures or forms that would allow AT&T to restructure its private-line services on a competitive basis.

Figure 6-1 shows the MPL rate structure for the three schedules of the tariff:

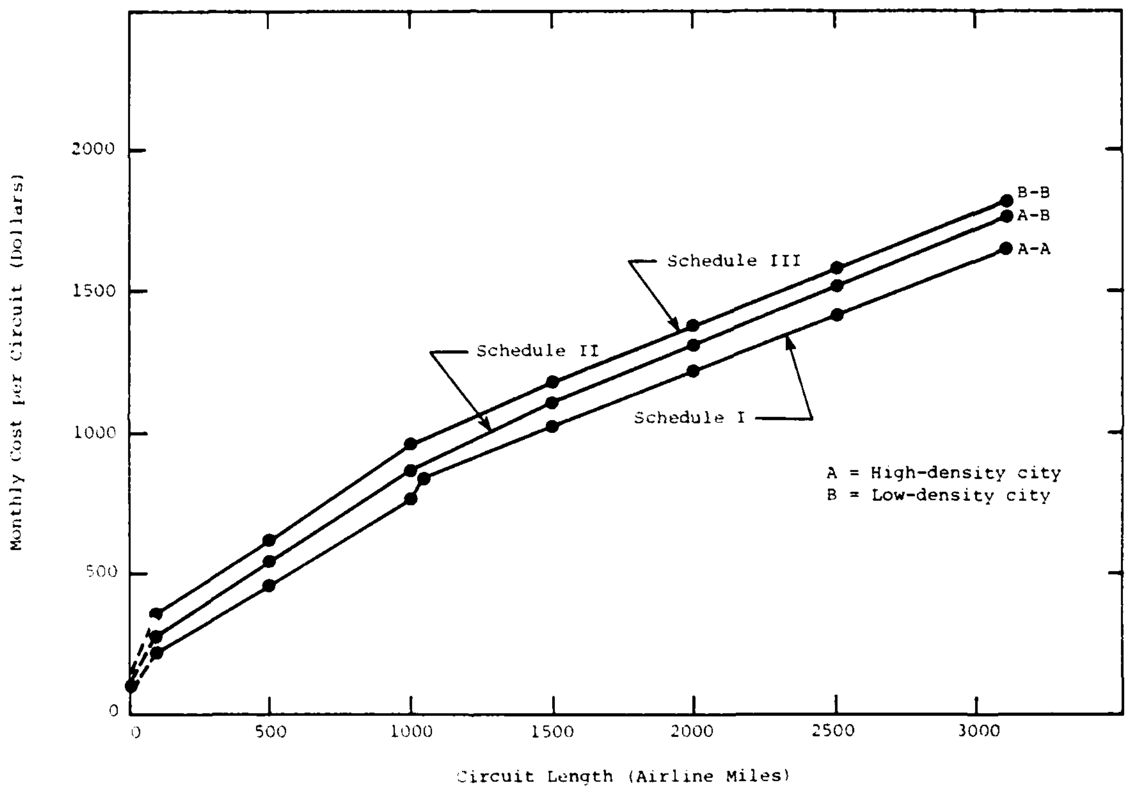


Figure 6-1. AT&T MULTISCHEDULE PRIVATE LINE SERVICE (MPL) SERIES 2000

Schedule I: A-A (High Density - High Density)

Schedule II: A-B (High Density - Low Density)

Schedule III: B-B (Low Density - Low density)

The 14 CTC-PAM elements used to calculate the cost of providing this service are listed in Table 6-1.

Table 6-1. CTC-PAM ELEMENTS USED TO CALCULATE COST OF AT&T'S MPL SERVICE		
Element	Quantity	Symbol
Basic terminal	2	BTE
Terminal inside wiring (business)	2	TWBE
Private-line access equipment (voice)	2	ALPL
Private-line access equipment (voice)	2	ALVE
Exchange trunk (private line)	2	ETBL
Intercity line haul	1	LHPL (j,m)*
End terminal multiplexer	2	EMPL (j,m)*
Intermediate terminal multiplexer	1	IMPL (j,m)*

*j = Density schedule I, II, or III.
m = Airline mileage.

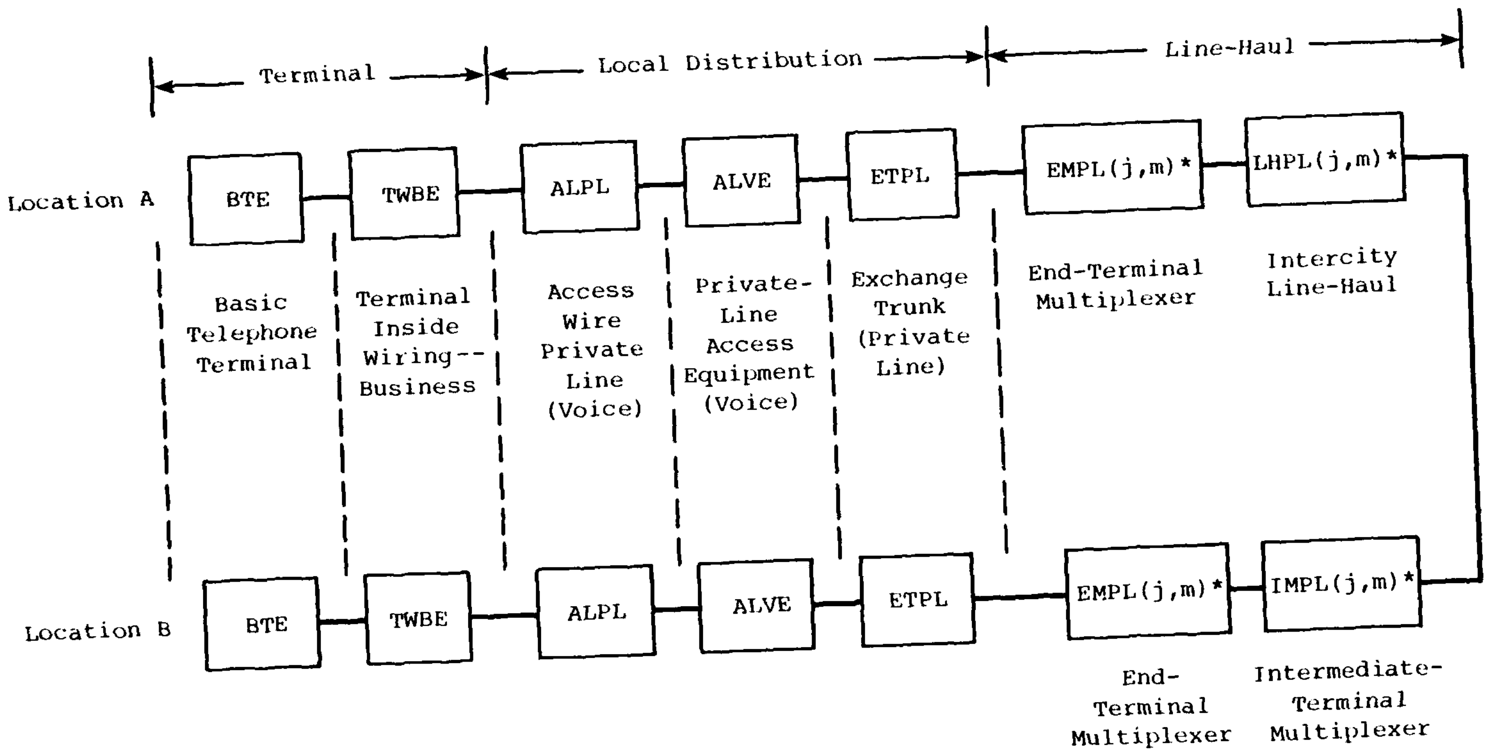
Figure 6-2 illustrates the configuration of the 14 private-line elements ("building blocks") necessary to provide MPL service.

The scenarios used in exercising the CTC-PAM to arrive at the MPL trends are presented in Table 6-2. Three scenarios (worst-case, best-case, and expected-case) are presented in Table 6-2, together with the associated quantitative changes (in percentage) expected for these scenarios. Figure 6-3 illustrates the resulting rate trends (based on a 1000-mile circuit) for the MPL Schedule I for the worst-case, best-case, and expected-case scenarios.

It is assumed that AT&T will not replace MPL during the period of our trend analysis. Should AT&T revise its private-line tariffs (the FCC having declared MPL unlawful), the tariff form would change but not the cost elements. This simply means that AT&T would have to restructure its tariffs in such a way that short-haul rates and other portions of the rate did not present an anticompetitive pricing barrier on the one hand and a predatory practice on the other hand.

Dicussions of the three postulated MPL scenarios follows.

We take up the worst-case scenario first. In our analysis three areas of significant change affect the cost of MPL: (1) the end terminal and (2) the intermediate terminal multiplexer costs and (3) the line-haul costs. All three cost components vary as a function of circuit distance, technology mix (e.g., the relative mix of T1-carrier to analog carrier such as N3), and unit cost of technology. Table 6-2 shows an annual 5.5 percent increase



j = 1, 2, or 3 for Schedules I, II, and III.
m = circuit length in airline miles.

Figure 6-2. MPL DIAGRAM OF ELEMENTS USED TO CONSTRUCT AT&T'S MPL SERVICE

Table 6-2. MPL TECHNOLOGY AND INFLATION SCENARIOS FOR TREND ANALYSIS				
Scenario	Equipment Affected by Factors	Equipment Unit Cost Change per Year (Percentage)	Effect of Inflation on Installation Labor (Percentage)	Effect of Inflation of Operating Costs (Percentage)
Worst Case	Line-Haul	+5.5	2	12
	End-Terminal Multiplexer	+2.0	1	12
	Intermediate-Terminal Multiplexer	+2.0	1	12
Best Case	Line-Haul	-1.5	2	<10
	End-Terminal Multiplexer	-2.0	1	<10
	Intermediate-Terminal Multiplexer	-2.0	1	<10
Expected Case	Line-Haul	3.5	2	10
	End-Terminal Multiplexer	0	1	10
	Intermediate-Terminal Multiplexer	0	1	10

in line-haul cost due to increased equipment costs. End terminal and intermediate terminal multiplexer costs increase at 2 percent per year because of increased equipment costs. Effective inflation on installation labor per unit of facility installed is judged at 2 percent for line-haul and 1 percent for end terminal and intermediate terminal multiplexers. Inflation affecting operating costs is 12 percent, which is 2 percent above the expected rate of 10 percent. As indicated in Table 6-3, the worst-case scenario produces an MPL cost increase of 22.2 percent and 50.7 percent in 1987 and 1994, respectively. This indicates that the short-term inflationary effect (i.e., during the first 7 years) is about 3 percent per year on a compounded basis, as indicated in Table 6-3.

For the best-case scenario Table 6-2 shows an overall decrease in equipment costs of about 2 percent per year due to infusion of new technology that changes the ratio of less expensive T1-carrier technology to the older N-carrier types. It is expected that improvements will occur in line-haul costs, but they will not have as drastic an effect on MPL costs as the use of new

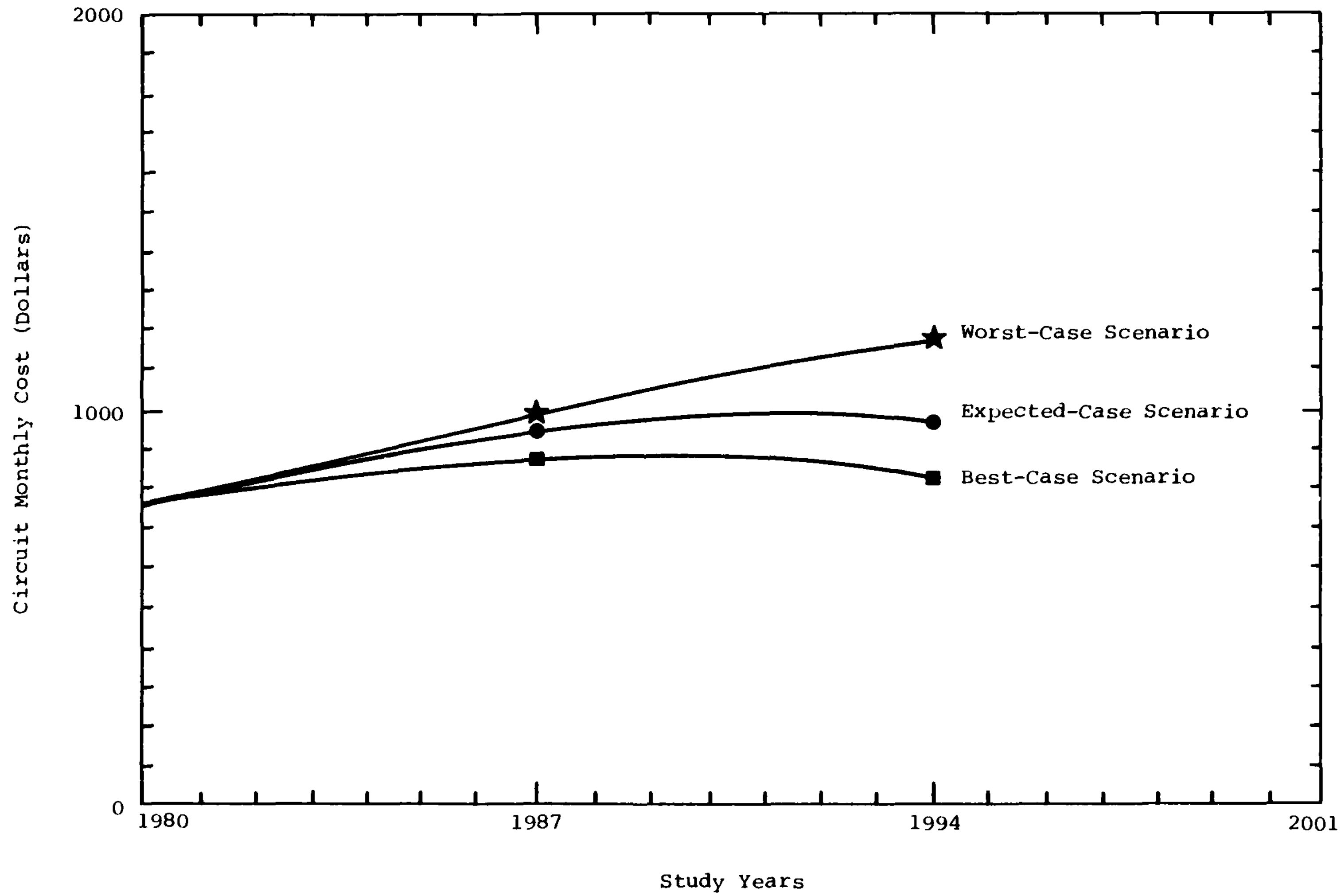


Figure 6-3. COST TRENDS FOR SCHEDULE I MPL BASED ON A 1000-MILE CIRCUIT LENGTH

Table 6-3. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR AT&T's MPL			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Annual Service Inflation Rate (Percentage)
Worst Case	1.222	1.507	3
Best Case	1.001	1.05	0.1
Expected Case	1.113	1.25	1.5

technology in the short-haul, end terminal, and intermediate terminal multiplexer facilities. Operating cost inflation is set at 8 percent. The expected cost increases for the service are 1.0 percent and 5.0 percent for 1987 and 1994, respectively, and the compounded inflation rate expectancy for the service is about 0.1 percent per year.

The expected-case scenario (see Table 6-2) shows an increase in unit cost of line-haul of 3.5 percent and no increase in carrier multiplexer costs over the study period. Inflation on installation maintains a status quo because there are no significant productivity changes and operating cost inflation is constant at 10 percent. Table 6-3 shows expected cost-of-service increases of 11.3 percent and 25 percent for 1987 and 1994, respectively. The overall short-term inflation rate for the service is expected to be in the range of 1.5 percent per year.

Table 6-4 depicts the proposed and trended (1987) rates for the three MPL schedules. This schedule reflects the regulatory issues as they concern short-haul price barriers for circuits shorter than 25 miles. The investment is high for the very short route, and short-haul users should pay their appropriate costs. MCI handles this issue by charging short-haul rates as follows:

Distance	Monthly Short-Haul Charge	Effective Short-Haul Cost per Mile
Up to 50 miles	$50.00	$1.00
Between 50 and 100 miles	30.00	0.80
Between 101 and 250 miles	20.00	0.40

If AT&T's current $51.00 per month Schedule I short-haul charge is allocated over, say, the first 25 miles, as in the MCI approach described above, a nominal $2.04 per circuit mile ($51 ÷ 25 miles) short-haul charge could be charged. This figure presumes that the short-haul user has an average circuit length of 25 miles. Another method of recovering high short-haul rates would be to separate local distribution from the MPL cost structure

Table 6-4. POSSIBLE MPL SHORT-TERM RATE STRUCTURE BASED ON EXPECTED-CASE FACTOR SCENARIO (ALL RATES IN DOLLARS)

Channel Miles	Proposed		Proposed 1987*	
	Fixed Rate	Per Mile Monthly Rate	Fixed Rate	Per Mile Monthly Rate
(a) Schedule I				
1-15	0	1.80		2.00
16-25	27.20	1.50	30.27	1.67
26-100	41.20	1.12	45.86	1.25
101-1,000	134.20	.66	149.36	.73
Over 1,000	718.20	.40	799.36	.45
(b) Schedule II				
1-15	0	3.30		3.67
16-25	56.20	3.10	62.55	3.45
26-100	77.20	2.00	85.92	2.23
111-1,000	107.20	1.35	119.31	1.50
101-1,000	188.20	.66	209.31	.73
Over 1,000	782.20	.40	870.59	.45
(c) Schedule III				
1-15	0	4.40	0	4.90
16-25	61.60	3.80	68.56	4.23
26-40	99.66	2.80	110.85	3.12
41-60	141.60	2.10	157.60	2.34
61-80	183.60	1.60	204.35	1.78
81-100	215.60	1.35	239.96	1.50
101-1,000	242.60	.68	270.01	.76
Over 1,000	854.60	.40	951.17	.45

*Based on expected-case factor scenario.

for pricing purposes. The local distribution for our studies is derived from the ALPL, ALVE, and ETPL elements of service (see Figure 6-2); these costs are well below AT&T's current rate for the first mile, again highlighting the tariff form issue. The local distribution costs for the expected-case scenario were determined to be $30.74 and $74.22 for 1980 and 1987, respectively. These figures correspond to the short-haul charge (for the first mile) of $1.23 per mile ($30.74 ÷ 25 miles) for 1980 and $2.97 per mile ($74.22 ÷ 25 miles) for 1987. These charges would apply, say, for the first 25 miles of a circuit; or, if the short-haul recovery were spread over the first 100 miles, the 1980 and 1987 rates would fall to $0.31 per mile and $0.74 per mile, respectively. It is not likely that AT&T would support distance-sensitive local distribution rates as described above. We think that AT&T would attempt to keep the local distribution rate in a lump-sum form to ensure cost recovery or to erect a price barrier against expensive short-haul circuits under 25 miles. There would be potential cross-elastic effects between MPL and DDD if there were no short-haul price barrier.

It is expected in our scenarios that AT&T will attempt to maintain a rate structure in which rates reflect the cost of provision or service. The main reasons for this expectation are the following:

- The cost of service between high-density areas will be lower than that of service between low-density areas. In fact the OCCs focus on large city areas because they present a larger market and facility costs are generally lower per circuit on heavy-traffic routes.
- MPL service will be able to provide the basic transmission element for basic private-line services as well as enhanced end-to-end private-line services. There will be no need to change present methods of cost studies very much.
- As soon as Telpak is withdrawn, a discounting schedule may be offered that will effectively discount the proposed MPL schedules to Telpak rate levels on the basis of such factors as total circuit miles and number of terminals leased, and perhaps a customer commitment to have a circuit in use for a specified period of time, which will increase the period over which circuit setup expenses may be amortized.

6.2.1.2 Trends in AT&T's Telpak Costs

AT&T's Series 5000 interstate private line service, known as Telpak, was offered to customers who require large circuit quantities or bandwidths. The service is heavily used by the General Services Administration, the Department of Defense, and several large industries such as the airlines and Conrail. The cost of Telpak bulk circuit capacity, relative to discrete circuit rates (e.g., MPL), reflects certain wholesale economies.

Telpak is offered in two service capacities:

Type	Bandwidth	Equivalent Voice-Grade Channels	Monthly Transmission Rate
5700	240 kHz	60	\$32.50/mile
5800	1 MHz	240	\$92.05/mile

For circuits of less than 25 miles, the rate is higher than that shown above. The Telpak monthly termination cost for voice or telegraph is \$43.30 per termination. Figure 6-4 shows the current per-circuit mileage costs for C and D Telpak circuits terminated at both ends given a 100 percent use of the capacities.

As mentioned earlier, Telpak will eventually be terminated because of the FCC's ruling that it was unlawful and because of AT&T's desire to withdraw the offering in the face of the sharing requirement. Considerable customer pressure and two favorable federal court rulings forced the FCC and AT&T to continue to offer Telpak to current customers until the case is finally resolved.

It is our opinion that the rule-making Docket 79-246, which was initiated in September 1979 to investigate AT&T's private-line rate structure, will solve the problem by changing Telpak into an equivalent service with an MPL-like rate coupled with possible discounting practices, as described in Chapter Three. Because of current regulatory trends (such as those set by Docket 20097) in permitting shared use and resale of private lines, trends that allow unregulated shared use of private-line facilities on a not-for-profit basis and resale of private-line facilities on a regulated basis, and because of the continued subscriber pressures, AT&T will be forced to move toward a discounting practice that will provide rates about the same as the present Telpak rates or somewhat higher.

There are two possible methods of discounting to formulate a Telpak equivalent. The first provides discounts based on MPL circuit densities between cities. For instance, for cities that are more than 1,000 airline miles apart, an MPL discount based on number of circuits leased between the cities is as follows:

The current monthly MPL cost is \$0.77 per mile, and the equivalent cost per mile for a single C Telpak (which contains 60 circuits) would be \$0.54 per mile per month, resulting in a discount rates of 70.4 percent $\left(\frac{\$0.54}{\$0.77}\right)$. This discount approach would offer two major benefits of Telpak to the carrier and subscriber: wholesale pricing for customers with large-scale leasing requirements, and more efficient use of carrier facilities. This alternative would be based upon the following:

- MPL city pair densities (e.g., A-A, A-B, and B-B density combinations)

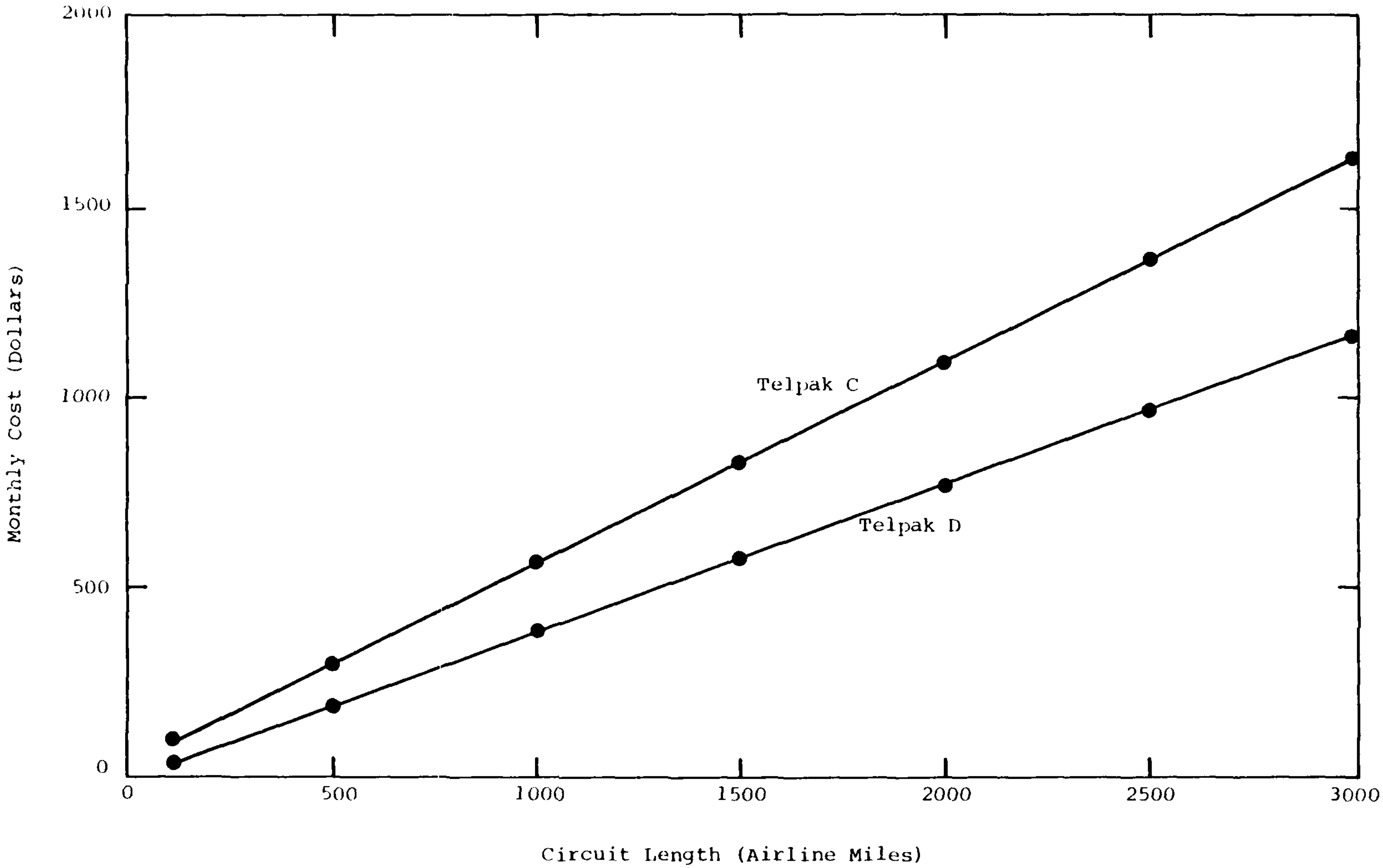


Figure 6-4. AT&T TELPAK SERVICE PER-CIRCUIT COSTS

* A possible linear discount that would reflect the percentage of fill of C and D Telpaks (60 and 240 circuits, respectively) and the total circuit miles leased between the city pairs

For our example, 60 A-to-A-city circuits, 1,000 miles in length, would have a 100 percent C Telpak fill and 60,000 circuit miles, and the discount schedule would provide a 70.4 percent discount of the MPL rates.

A second discounting approach could be based on the total circuit miles leased by a customer without reference to the particular intercity circuit densities. In this method, discounting is based not on route fills, as in the previous approach, but rather on number of circuits under lease from AT&T.

Having described the current Telpak offering, the regulatory issues surrounding this service, and several discounting apr aches to providing lower-cost private-line services to high-volume users .. the absence of Telpak, we now address the exercising of the CTC-PAM to predict Telpak cost trends. Although it is not expected that Telpak will survive through the 1994 study year, these cost trends are representative of the lowest rates AT&T could offer a high-volume user.

We considered numerous scenarios in examining the variability of Telpak rates with respect to changes in inflation rates and technology. We observed that Telpak had a low carrier cost as a result of the higher fills and the direct routing of Telpak circuits. The eight service elements that constitute Telpak are listed in Table 6-5.

Table 6-5. ELEMENTS OF TELPAK

Description	Quantity (C/D)	Symbol
Basic terminal	Up to 120/480	BTE
Terminal wiring--business	120/480	TWBE
Access line wiring--business	120/480	ALPL
Access line voice conducting--business	120/480	ALVF
Exchange trunk--business	120/480	ETBE
Intercity line-haul		
60 channels	1	LHTC(m)
240 channels	1	LHTD(m)
End terminal multiplexer--bulk		
60 channels	1	EMTC(m)
240 channels	1	EMTC(m)
Intermediate terminal multiplexer--bulk		
60 channels	1	IMTC(m)
240 channels	1	IMTD(m)

m = mileage.

Figure 6-5 illustrates the Telpak cost trends, based on a 1,000-mile circuit and 100 percent use of circuits. The curves in this figure illustrate worst-case, best-case, and expected-case scenarios. The best-case scenario allows for a slight change in technology unit cost to reflect new-technology infusion over the first 4 years for the LHTC, LHTD, IMTC, IMTD, EMTC, and EMTD cost elements; the technology impact is considered negligible beyond the first 4 years. Inflation for this best case was assumed to be 8 percent. The worst case predicted a unit cost increase of about 4 percent for the first 4 years and 2 percent thereafter, and inflation was trended at 12 percent for all the variables cited. In the expected case, technology infusion does not affect the element costs, and inflation was assumed to be 10 percent.

We believe Telpak will be replaced by a volume-discounted MPL type of offering and that the minimum cost threshold for this service is representative of the values shown in Figure 6-5.

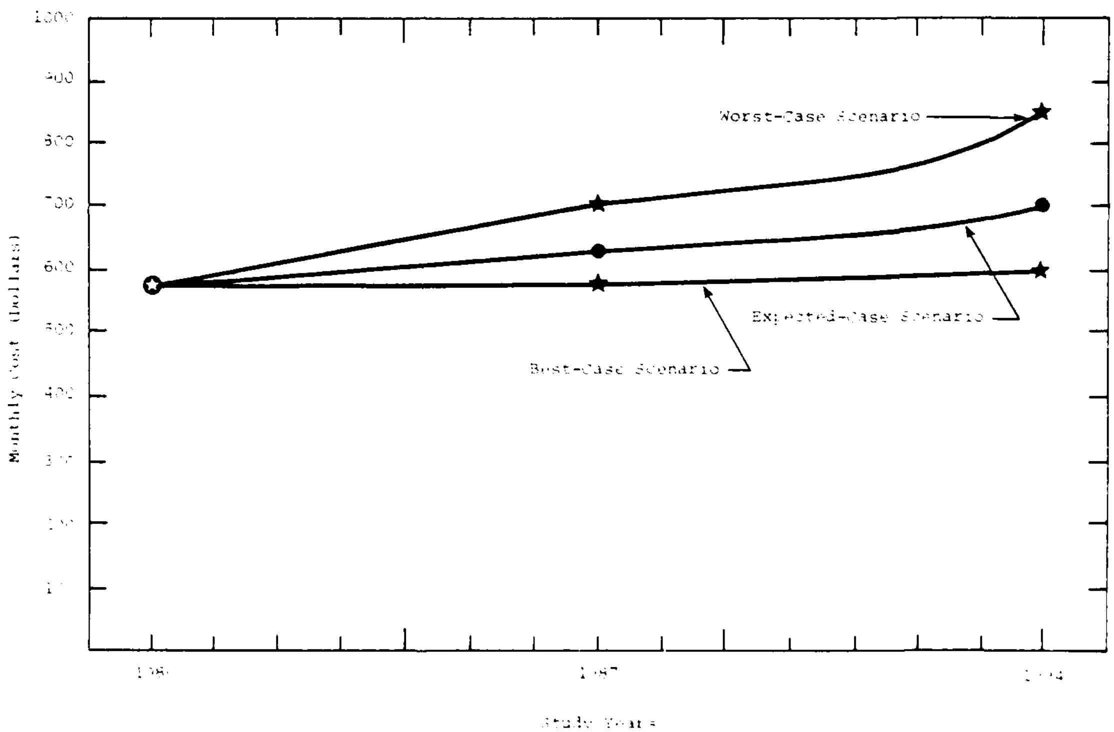


Figure 6-5. TELPAK COST TRENDS FOR A 1000-MILE CIRCUIT

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DESCRIPTION AND ANALYSIS OF TRENDS IN CONUS COMMON CARRIER OFFE--ETC(U)
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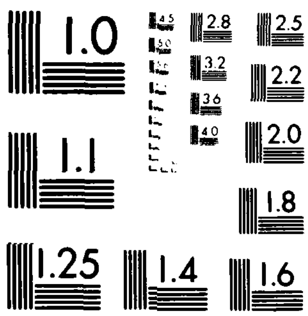

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963-A

6.2.1.3 AT&T's Digital Service (DDS) Cost Trends

AT&T's Dataphone Digital Service (DDS) was announced in 1974 as an interstate private-line digital data transmission service offering. DDS currently serves more than 50 major cities and is rapidly expanding to other cities. It is implemented in part by the data-under-voice (DUV) technique, which uses the frequency band below the frequency-modulated microwave radio baseband. Extensive regulatory battles over the issues surrounding this service resulted in an FCC ruling that the DDS rates were predatory and anticompetitive. The FCC cited low rates that did not reflect the costs of developing and providing the service. AT&T issued new rates, and the FCC again received complaints that the rates were anticompetitive. The proceedings are continuing, and the DDS rates are subject to upward change pending FCC findings.

The DDS service is full-period, 24-hour service that provides full-duplex facilities at transmission rates of 2.4, 4.8, 9.6, 56, and 1544 Kbps. Additional cities to be included in the service number 42. The DDS system does not require a data modem and provides a simple connection to the customer's equipment through a data service unit (DSU) or a digital station terminal (DST). Figures 6-6 through 6-8 show the monthly costs for various DDS data rates as a function of circuit length. The DST provides an access line and control function to the nearest DDS channel entry point and is required for all data rates except 1.544 Mbps. There are three types of DSTs:

- *Type I provides all functions for the customer's equipment (e.g.,* timing and control functions). The rates for Type I are as follows:

Speed (bps)	Monthly Rate
2,400	$ 84.55
4,800	160.00
9,600	281.33
56,000	650.00

- Type II requires the customer to furnish timing and coding functions. The rates for Type II are as follows:

Speed (bps)	Monthly Rate
2,400	$ 69.10
4,800	144.55
9,600	265.88
56,000	629.40

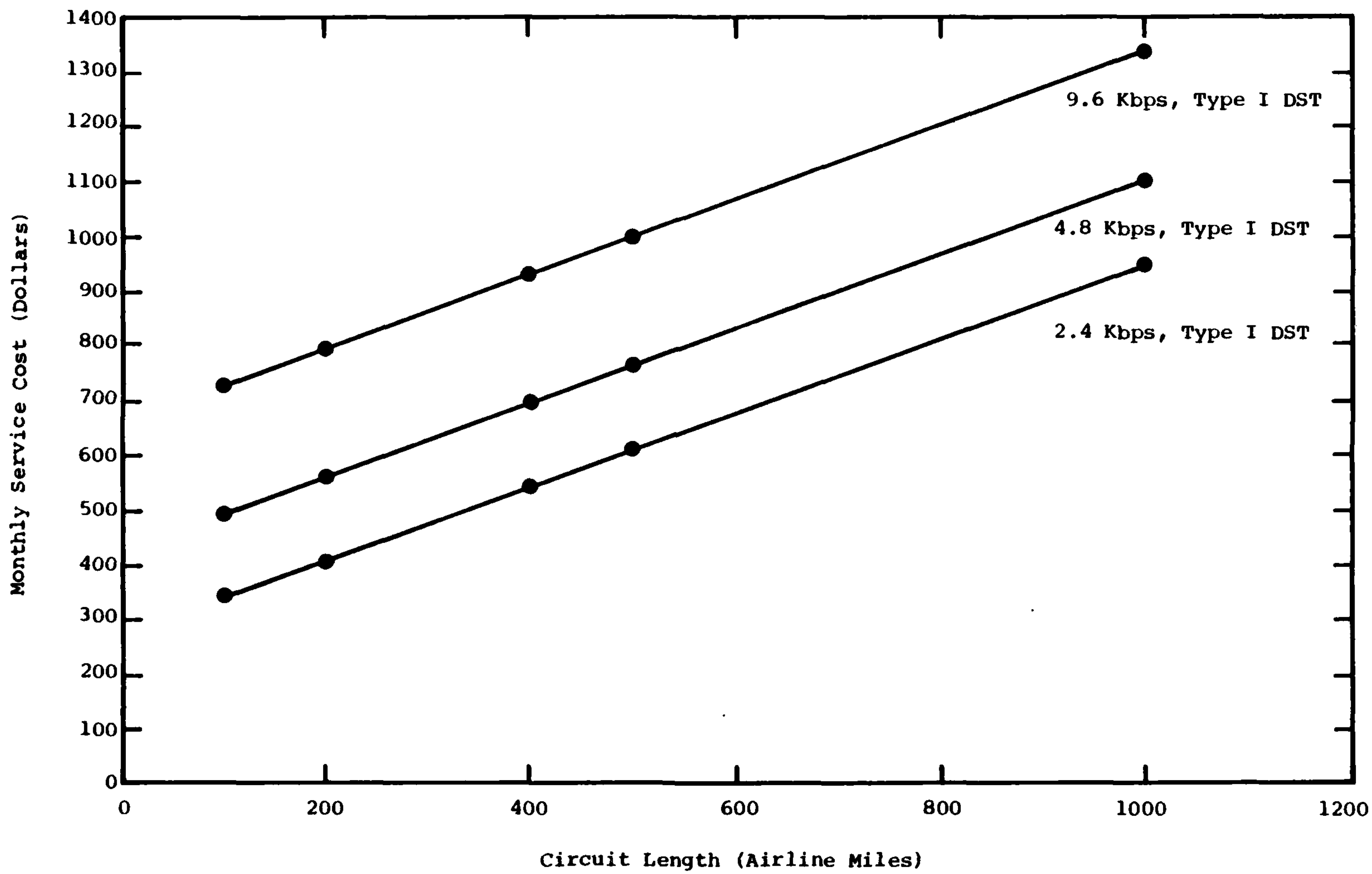

Figure 6-6. **AT&T DATAPHONE DIGITAL SERVICE (DDS)**

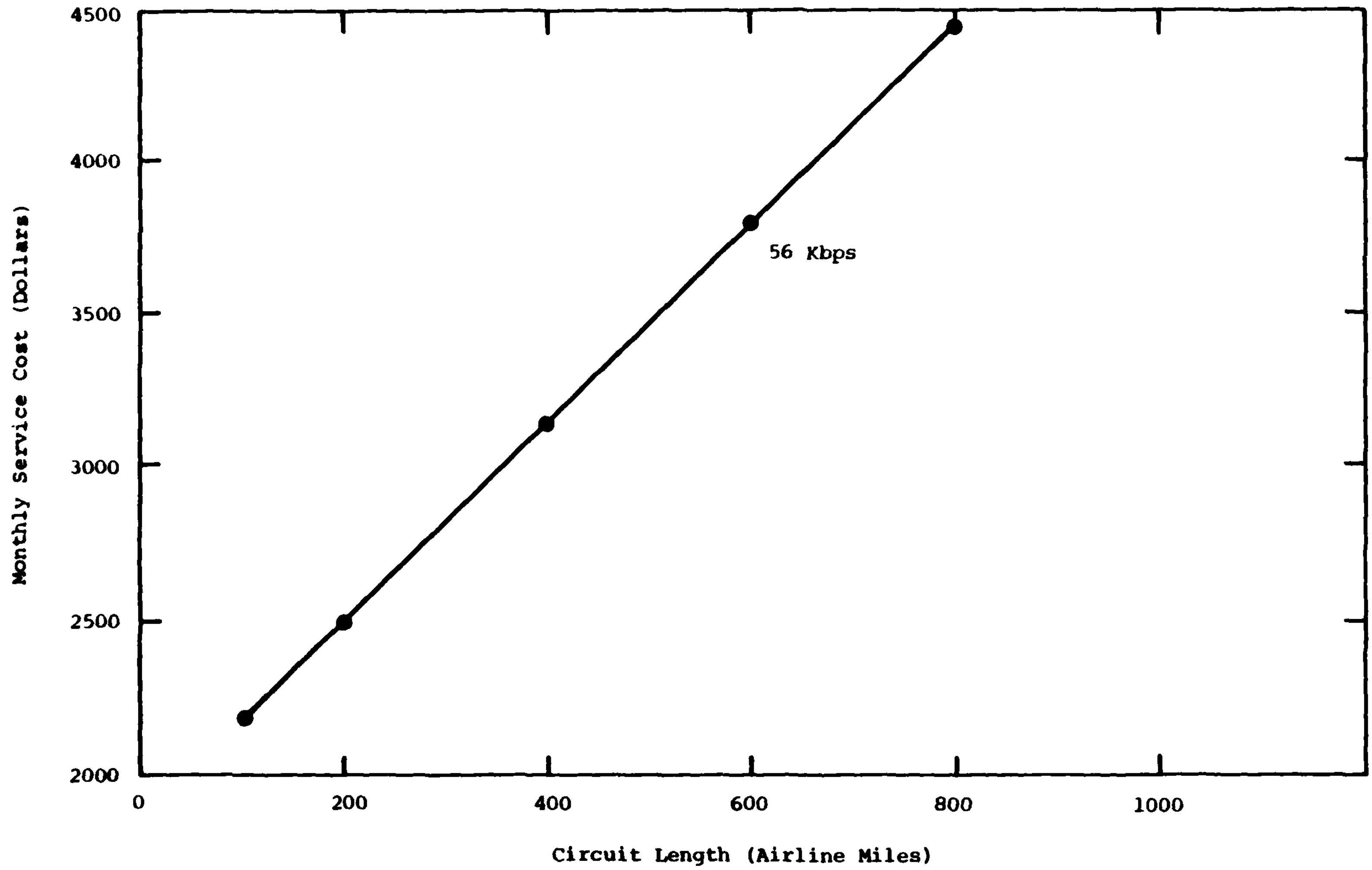

Figure 6-7. **AT&T DATAPHONE DIGITAL SERVICE (DDS) -- 56 Kbps**

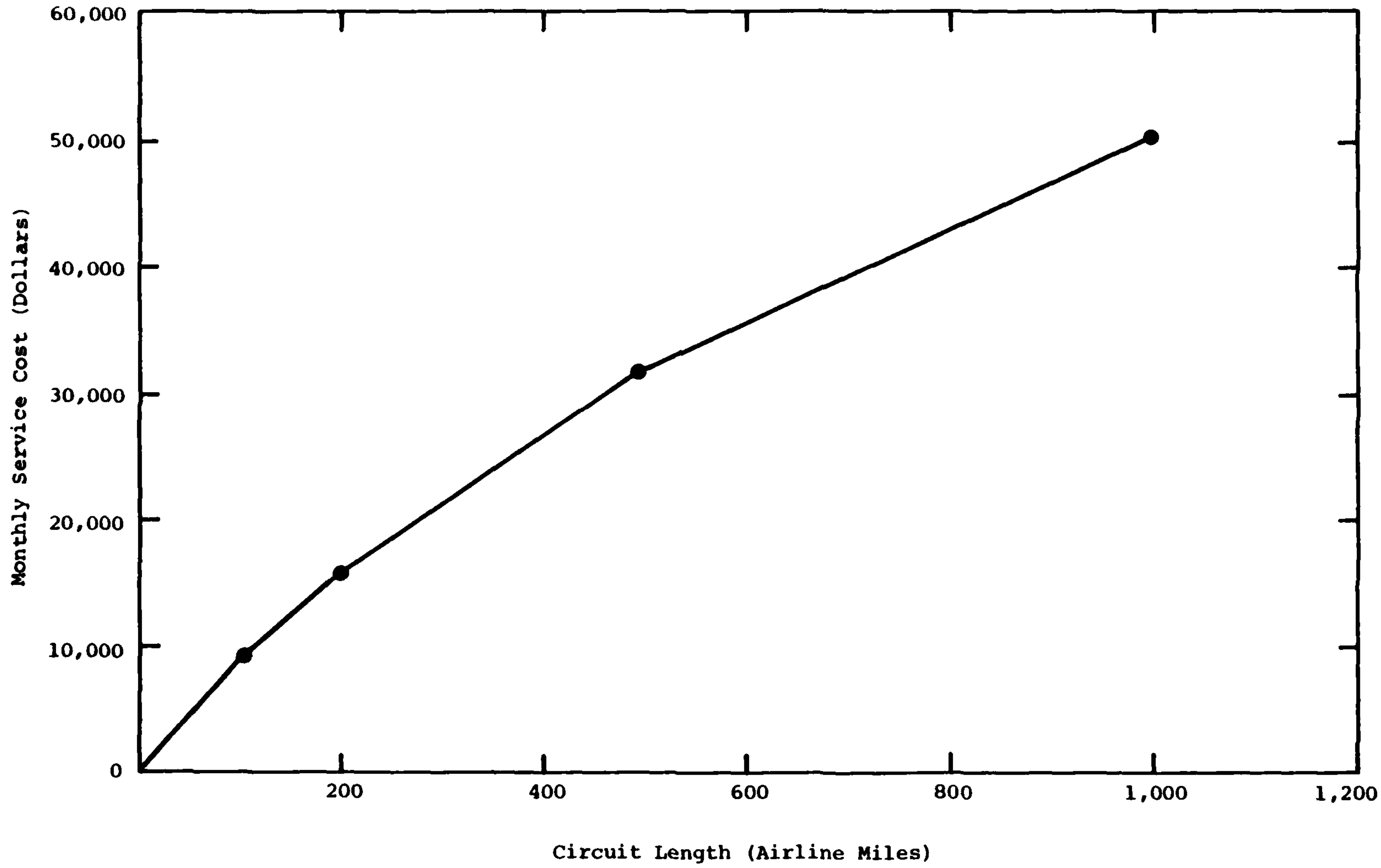

Figure 6-8. AT&T DATAPHONE DIGITAL SERVICE (DDS) 1.544 Mbps

- Type III allows the customer to connect a separate voice-grade channel between his site and a DDS service access point. The rates for Type III are as follows:

Speed (bps)	Monthly Rate
2,400	$ 25.00
4,800	25.00
9,600	32.33
56,000	125.00

The CTC-PAM cost elements used to develop cost trends for the DDS service are listed in Table 6-6.

Table 6-6. CTC-PAM ELEMENTS USED FOR DDS

Element	Quantity*	Symbol
Local Access - Digital	j	LAD
Exchange Trunk - Digital	j	ETD
Intercity Line-Haul - Digital	j	LHD
End-Terminal Multiplexer - Digital	j	ETD
Intermediate-Terminal Multiplexer - Digital	j	ITD

*When j = 1, it represents 2.4 Kbps.
When j = 2, it represents 4.8 Kbps.
When j = 3, it represents 9.6 Kbps.
When j = 4, it represents 56 Kbps.
When j = 5, it represents 1.544 mbps.

All five cost elements are differentiated with respect to the data rate to be studied, and the last three components are costs that vary with circuit mileage.

Table 6-7 summarizes the worst-case, best-case, and expected-case scenarios associated with DDS. All technology is current, and the service is expected to lie between the worst-case and best-case scenarios because of sizeable increases in price as a result of regulatory pressure from the FCC.

The CTM-PAM model was exercised with the three inflation scenarios depicted in Table 6-7 for DDS data rates of 2.4, 4.8, 9.6, 56, and 1544 Kbps. The results are as follows:

- 2.4 Kbps. The trend analysis for 2.4 Kbps short-term, long-term, and short-term compound inflation rates is given in Table 6-8. As indicated for the 2.4 Kbps data rate, costs are expected to increase 72.6 percent in 1987 and almost triple by 1994. The short-term (1987) compound service inflation rate is expected to be 8.1 percent.

Table 6-7. INFLATION RATE SCENARIOS ASSOCIATED WITH AT&T'S DDS			
Scenario	Equipment Cost Inflation (Percentage)	Installation Cost Inflation (Percentage)	Operating Cost Inflation (Percentage)
Worst Case	5.5	2	12
Best Case	-1	1	8
Expected Case	3.5	1	10

Table 6-8. SHORT-AND LONG-TERM INFLATION FACTORS FOR AT&T'S DDS (2.4 Kbps)			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	2.082	4.082	11.0
Best Case	1.425	2.160	5.2
Expected Case	1.726	2.977	8.1

- 4.8 Kbps. The trend analysis for the DDS 4.8 Kbps data rate inflation factors is given in Table 6-9. As indicated, the service is expected to increase in cost 73.2 percent by 1987 and triple by 1994. The short-term (1987) compound service inflation rate is 8.2 percent.

Table 6-9. SHORT- AND LONG-TERM INFLATION FACTORS FOR AT&T'S DDS (4.8 Kbps)			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	2.081	4.068	11.0
Best Case	1.434	2.174	5.3
Expected Case	1.732	2.979	8.2

- 9.6 Kbps. Trend analysis factors for the DDS 9.6 Kbps data rate are given in Table 6-10. As indicated, the service is expected to increase in cost 73.2 percent by 1987 and triple in cost by 1994. The short-term compound inflation rate is 8.2 percent.

Table 6-10. SHORT- AND LONG-TERM INFLATION FACTORS FOR AT&T'S DDS (9.6 Kbps)			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	2.069	4.051	10.9
Best Case	1.446	2.192	5.4
Expected Case	1.732	2.986	8.2

- 56 Kbps. Table 6-11 presents the trend analysis inflation factors for the DDS 56 Kbps data rate. As indicated, an increase in service cost of 74.4 percent and 302 percent is expected over the next 7 and 15 years, respectively. The short-term (1987) compound inflation rate is expected to be approximately 8.3 percent.

Table 6-11. SHORT- AND LONG-TERM INFLATION FACTORS FOR AT&T'S DDS (56 Kbps)			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	2.059	4.052	10.9
Best Case	1.476	2.246	5.7
Expected Case	1.744	3.024	8.3

- 1.544 mbps (1544 Kbps). Table 6-12 presents the trend analysis inflation factors for the high-capacity 1.544 Mbps (T1-carrier) service. This is expected to become more popular as the Bell inter-city DDS service points expand to include this data rate. The cost of this service is expected to increase about 74 percent by 1987 and to triple by 1994. The overall short-term (1987) compound annual service inflation rate is expected to be approximately 8.1 percent.

Our trend analysis indicates that all of the DDS service data rates will experience similar inflation rates in short-term and long-term cost projections. The similarity in rate of change of cost is due to the similarity in transmission, multiplexer, and other terminal equipment used in the service to provide the DDS hierarchy and common maintenance and repair activities. As mentioned earlier, perhaps the most dominant factor now affecting the DDS service is the FCC's pressure on AT&T. We do not expect that increases in rates under this pressure will exceed the worst-case

Table 6-12. SHORT- AND LONG-TERM INFLATION FACTORS FOR AT&T'S DDS (1544 Kbps)			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.97	3.84	10.2
Best Case	1.52	2.28	6.2
Expected Case	1.73	2.96	8.1

extreme. Should the regulatory pressures subside, AT&T will probably not increase prices and will thus maintain a competitive edge in data transmission.

6.2.1.4 <u>Cost Trends for AT&T's Wide Area Telecommunications Service (WATS)</u>

In May 1976 the FCC ruled that WATS was illegal. In its ruling the FCC indicated that the reasons for allowing preferential rates of long-haul over short-haul users were not persuasive and ordered AT&T to file revisions. On 29 April 1977, AT&T responded to the FCC order and filed major tariff revisions, which were to become effective in August 1977. In July 1977 the FCC rejected the filing for lack of cost justification. The tariff rates now in effect are subject to change, and it is expected that the service pricing methodology will be changed as well.

WATS costs are based on a flat monthly charge for accumulated usage not exceeding a specified number of hours. All calls have to be within specified call areas. Usage beyond a specified amount is charged overtime rates. Calls are metered and time accumulated in 6-second intervals, and overtime is billed on 6-minute increments.

The CTC-PAM service elements used to perform trend analysis for the WATS service are listed in Table 6-13.

Table 6-14 gives the inflation for worst-case, best-case, and expected-case scenarios.

Table 6-15 gives the WATS service cost-increase expectancies for the associated worst-case, best-case, and expected-case scenarios. As indicated, WATS is expected to increase 27 percent by 1987 and almost triple by 1994. The short-term (1987) compound inflation rate is expected to be 3.5 percent per annum. In response to the FCC actions cited earlier, it is expected that WATS will be offered in a somewhat different form to differentiate the service from MTS.

6.2.1.5 <u>Trends in AT&T's Local Distribution Costs</u>

Bell provides local distribution facilities associated with its own service offerings as well as the offerings of other common carriers. We

Table 6-13. CTC-PAM ELEMENTS USED FOR WATS		
Element	Quantity	Element
Terminal	1	BTE or KTE
Terminal - Business Wiring	1	TWBE
Access Line Wire - In/OutWATS	1	ALOW/ALIW
Exchange Trunk - Out/InWATS	1	ETOW/ETIW
Local Switching - Out/InWATS	1	LSOW/LSIW
Toll Switching - Out/InWATS	1	TSOW/TSIW
Intercity Line Haul - Out/InWATS	1	LHOW/LHIW
End-Terminal Multiplexer - Out/InWATS	1	EMOW/EMIW
Intermediate-Terminal Multiplexer - Out/InWATS	1	IMOW/IMIW

Table 6-14. AT&T WATS SERVICE INFLATION SCENARIOS			
Scenario	Equipment Cost Inflation Rate (Percentage)	Installation Cost Inflation Rate (Percentage)	Operating Cost Inflation Rate (Percentage)
Worst Case	5.5	2	12
Best Case	2.0	1	8
Expected Case	3.0	1	10

Table 6-15. TRENDS IN AT&T'S WATS COSTS			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.50	3.21	6.0
Best Case	1.15	2.46	2.0
Expected Case	1.27	2.72	3.5

performed a separate CTC-PAM study of local distribution in order to establish the cost volatility of this Bell service and to gain a feeling for possible recommendations and alternatives for DCA.

Of key interest to our trend analysis is the impact of local distribution cost increases on the other common carriers. In general, the tariff governing the regulations applicable to circuits provided by the Bell System operating companies to patrons of OCCs is contained in AT&T's Tariff FCC No. 3. Rates and charges for various circuit arrangements are specified in AT&T, Long Lines Department Tariff 266.

Two types of local distribution were studied that are most applicable:

- Local distribution without local switching function. All facilities from the patron's terminal to his central office and then to the OCC's service center are hardwired, with no switching access required.
- Local distribution with switching required. A switching element allows traffic to be switched in either direction (i.e., from an OCC center or to an OCC center) without the use of dedicated private-line facilities.

The CTC-PAM model has a service referred to as ENFIA, which is used to establish cost trends reflecting costs for the OCCs' interstate use of local exchange facilities. The CTC-PAM cost elements associated with local distribution arrangements are listed in Table 6-16.

Table 6-16. CTC-PAM ELEMENTS FOR AT&T'S LOCAL DISTRIBUTION

Element	Quantity	Symbol
Basic Telephone	1	BTE
Terminal Wiring - Business	1	TWBE
Access Line - Business Wire	1	ALBE
Access Line - Voice Conducting	1	ALVE
Exchange Trunk	1	ETOW
Local Switching	0 or 1*	LSOW
Exchange Trunk - Business	1	ETBE

*The quantity is 0 where switching facilities are not required.

There are two major types of plant that provide conducting paths for local distribution: aerial cable and buried cable. New fiberoptic technology is considered too premature for inclusion as an alternative technology in our scenarios because fiberoptics has been used primarily for major transmission links as opposed to distribution to subscribers.

Switching technology is of three types: (1) step-by-step, (2) crossbar, and (3) electronic switching system. Since standard technology scenarios contained in the CTC-PAM data base provide for modernization of switching plant at a realistic rate, we did not modify switching equipment technology

infusion rates, recognizing that substantial investments exist in the local central offices and technical change will be moderate.

Table 6-17 gives the inflation factors used for the worst-case, best-case, and expected-case local distribution scenarios.

Table 6-17. INFLATION RATES ASSOCIATED WITH AT&T LOCAL DISTRIBUTION COSTS

Scenario	Equipment Cost Inflation Rate (Percentage)	Installation Cost Inflation Rate (Percentage)	Operating Cost Inflation Rate (Percentage)
Worst Case	9	6	12
Best Case	7	6	8
Expected Case	8	6	10

Table 6-18 gives the short- and long-term inflation factors for AT&T's local distribution costs and associated short-term (1987) compound inflation rate. As indicated, local distribution costs are expected to increase between 63 percent and 70 percent by 1987 and almost triple by 1994, and the associated short-term (1987) compound local distribution inflation rate is expected to be between 7.3 percent and 7.9 percent.

Table 6-18. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR AT&T's LOCAL DISTRIBUTION COSTS

Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case			
• With Local Switching Access	1.961	3.758	10.1
• Without Local Switching Access	1.950	3.800	10.0
Best Case			
• With Local Switching Access	1.368	2.002	4.6
• Without Local Switching Access	1.350	2.000	4.4
Expected Case			
• With Local Switching Access	1.700	2.800	7.9
• Without Local Switching Access	1.634	2.757	7.3

6.2.1.6 Cost Trends for AT&T's Common Control Switching Arrangement (CCSA)

CCSA provides voice switching to allow call completion through private-line channels to subscriber stations in a large network. This service is

rapidly being replaced by the AT&T Enhanced Private Switched Communication Service (EPSCS) because the EPSCS service allows more network management features and enhanced services. The loss of CCSA subscribers to EPSCS is freeing equipment that may not be reused, and this fact, together with a revenue requirement of 29 percent (to bring service rates to a level that would produce an objective 9.5 percent return rate), has caused considerable rate pressure on existing subscribers. Continued migration of CCSA's major users to EPSCS and OCC-offered CCSA will produce further rate instability.

The CCSA service is composed of nine different CTC-PAM service elements, as listed in Table 6-19.

Table 6-19. CTC-PAM ELEMENTS FOR CCSA

Cost Element	Number of Elements	Symbol
Interexchange access line termination from a customer station	n*	CC9E9
Access line termination including channel from customer station located in same exchange	n	CC9F9
Trunk line termination from another CCSA or SCAN switching arrangement	n	CC9G9
OCC access line termination from a customer station	n	CCXXB
OCC trunk line termination from another CCSA switching arrangement	n	CCSSD
Arrangement to provide automatic message accounting from access line groups of preceding month's calls	n	CC9FF
Arrangement to permit a private line network employing a CCSA to automatically interconnect channels for private-line telephone services with central offices (for toll and exchange service)	n	CCS52
A route-advance arrangement to permit a call originating on a CCSA and finding a first-choice route busy to advance to an alternate route	n	CCU1H
A restricted class arrangement provided to restrict access to a selected list of area and exchange codes	n	CCXXA

*n indicates an optional quantity of service components; $n \geq 0$.

Elements of CCSA service are optional and are usually selected in accordance with a particular user's needs. CCSA service usually has the following features:

- Multiple CCSA service locations or nodes as required by the customer
- Local business access lines for local calling and toll use
- WATS lines to provide a network option to toll
- Intermachine trunks that connect two or more CCSA nodes together to form a private-line switched network
- Foreign exchange lines providing foreign exchange area access from the CCSA network or providing access to the network from a foreign exchange

Table 6-20 gives the inflation rate scenarios associated with AT&T's CCSA service offering. The worst-case scenario, with subscriber loss to EPSCS, is expected to prevail. The other cases are given to illustrate cost trends in the absence of a major cross-elastic effect between competing services.

Table 6-20. AT&T CCSA INFLATION RATE SCENARIOS

Scenario	Equipment Cost Increase (Percentage)	Operating Cost Increase (Percentage)
Worst Case		
• Without loss of subscribers to EPSCS	5	12
• With loss of subscribers to EPSCS	30	29
Best-Case	1	8
Expected-Case	3	10

Table 6-21 depicts the cost trends for the CCSA service. Since the service is expected to be phased out by AT&T, CCSA is expected to follow the trends associated with the worst case -- the loss of subscribers to EPSCS. This will cause approximately a tripling in service cost by 1987, with no service being likely in 1994. The short-term (1987) compound inflation rate is expected to be on the order of 15.5 percent per year.

6.2.1.7 Cost Trends for AT&T's Enhanced Private Switched Communications Service (EPSCS)

In December 1978, AT&T issued tariffs for EPSCS, a sophisticated private-line switching service containing many advanced features that could competitively meet the needs of private-line networks of intermediate and large size. Switching centers for EPSCS are located at specified rate

Table 6-21. TRENDS IN AT&T CCSA EXPECTED COSTS			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case			
• Without loss of subscribers to EPSCS	1.705	3.437	7.9
• With loss of subscribers to EPSCS	2.705	No Service	15.5
Best Case	1.441	2.215	5.4
Expected Case	1.566	2.749	6.6

centers, which contain ESS offices. The service is subject to a minimum lease of 125 switching terminals for a single switching center and a minimum of 700 switching terminals per system. Rates for the service are given in Table 6-22.

Table 6-22. EPSCS SERVICE RATES	
Service Feature/Equipment	Monthly Rate (Dollars)
Switching terminal	
• For customer Station	66.00
• For WATS, FX, or central office trunk	66.00
Customer network center	
• Visual display unit	270.00
• Low-speed printer with keyboard	200.00
• High-speed printer	375.00
Calling features	
• Per list of 3- or 6-digit codes	100.00
• Special restriction	55.00
• Per outgoing route arranged (call queuing)	100.00
• Each additional time slot (call queuing)	30.00
• Abbreviated dialing per 3-digit access code	6.00
Economic route selection	62.50
Circuit group display status	75.00

Analysis of the cost trends for EPSCS requires a single cost element, an EPSCS general port element, or EPSGP. The worst-case, best-case, and expected-case inflation scenarios are depicted in Table 6-23.

Table 6-23. EPSCS INFLATION SCENARIOS

Scenario	Equipment Cost Increase (Percentage)	Operating Cost Increase (Percentage)
Worst Case	6	12
Best Case	3	8
Expected Case	5	10

Table 6-24 summarizes the worst-case, best-case, and expected-case short-term and long-term and compound annual inflation rates for the EPSCS service. As indicated, the service is expected to increase 40 percent in the short term (by 1987) and is expected to more than triple in the long term (by 1994). The annual compound inflation factor for the short term is expected to be 5 percent.

Table 6-24. SHORT- AND LONG-TERM INFLATION FACTORS FOR AT&T EPSCS SERVICE

Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.57	3.94	7.0
Best Case	1.23	2.28	3.0
Expected Case	1.40	3.01	5.0

6.2.2 SPCC Service Offering Trends

SPCC has a substantial financial foundation: it is a wholly owned subsidiary of the Southern Pacific Company, which is a diversified leader in the transportation industry. The parent has been in the forefront of communications since 1965, to meet the requirements of its rail business. Today the Southern Pacific Company owns and operates the largest private communications system in the United States. SPCC's assets (we separate them from the parent company's assets) exceed $3 billion, and its network represents the most modern technology in use today.

Perhaps the most remarkable aspect of SPCC's history is its initiative in the marketplace. More than 70 major metropolitan areas are served by its coast-to-coast microwave relay network. This network provided most of SPCC's

private-line revenues. In late 1977, however, SPCC began marketing a new generation of low-cost switched transmission services that permit subscribers to share the use -- and expense -- of leased lines. In 1977 and 1978 a series of court decisions led to a ruling that AT&T could no longer refuse to provide local interconnections requested by OCCs, thus unlocking the door to the SPCC switched services. Since January 1978, SPCC's volume of switched services has risen from less than 10 percent to more than 40 percent of its average revenues, and its customer base has increased from 1,100 to 14,000.

The fundamental financial strength of SPCC is clearly indicated by its construction expenditures. In 1978 its capital expenditures exceeded $21 million. SPCC extended its switched network to 36 more cities, tripled switching capacity, and initiated a $20 million project that doubled circuit capacity between the Midwest and the west coast. In 1979 SPCC placed $50 million in notes with two lenders to finance additional construction of switching centers and transmission facilities for major metropolitan areas in the western United States. We expect that SPCC's success in the telecommunications market place will continue because of its financial strength, innovative service development, and strong technical expertise. In this study we focused on its private-line transmission service and its switched private network telecommunications services, because these are the primary services offered by SPCC.

6.2.2.1 Private-Line Service

SPCC's private-line service exemplifies the competitive and user-tailored service that the majority of SPCC's business users of communications subscribe to. The service offers full-period or partial-period point-to-point interstate service for teleprinter, voice, data, and wideband transmission. Charges for these service options are as follows:

Full Period

Rates for full-period service consist of (1) an intercity mileage charge, (2) a channel termination charge, and (3) a local access channel charge. Channels are offered for transmission of digital data at a specified speed or as analog channels with bandwidths equivalent to 1 to 240 voice-grade channels. Full-period mileage charges are broken into three categories: low-speed data, medium-speed data, and voice, as follows:

- Low-speed data channels (up to 300 bps)

  0-75 bps: $0.22 per mile per month
  0-150 bps: 0.32 per mile per month
  0-300 bps: 0.44 per mile per month

- Medium-speed data channels (600-9600 bps). The rates for this service are given in Table 6-25.

- Voice-Grade Channels. Figure 6-9 shows the monthly rate structure for SPCC's private-line voice-grade service as a function of circuit length, and also the range of monthly cost per circuit based on

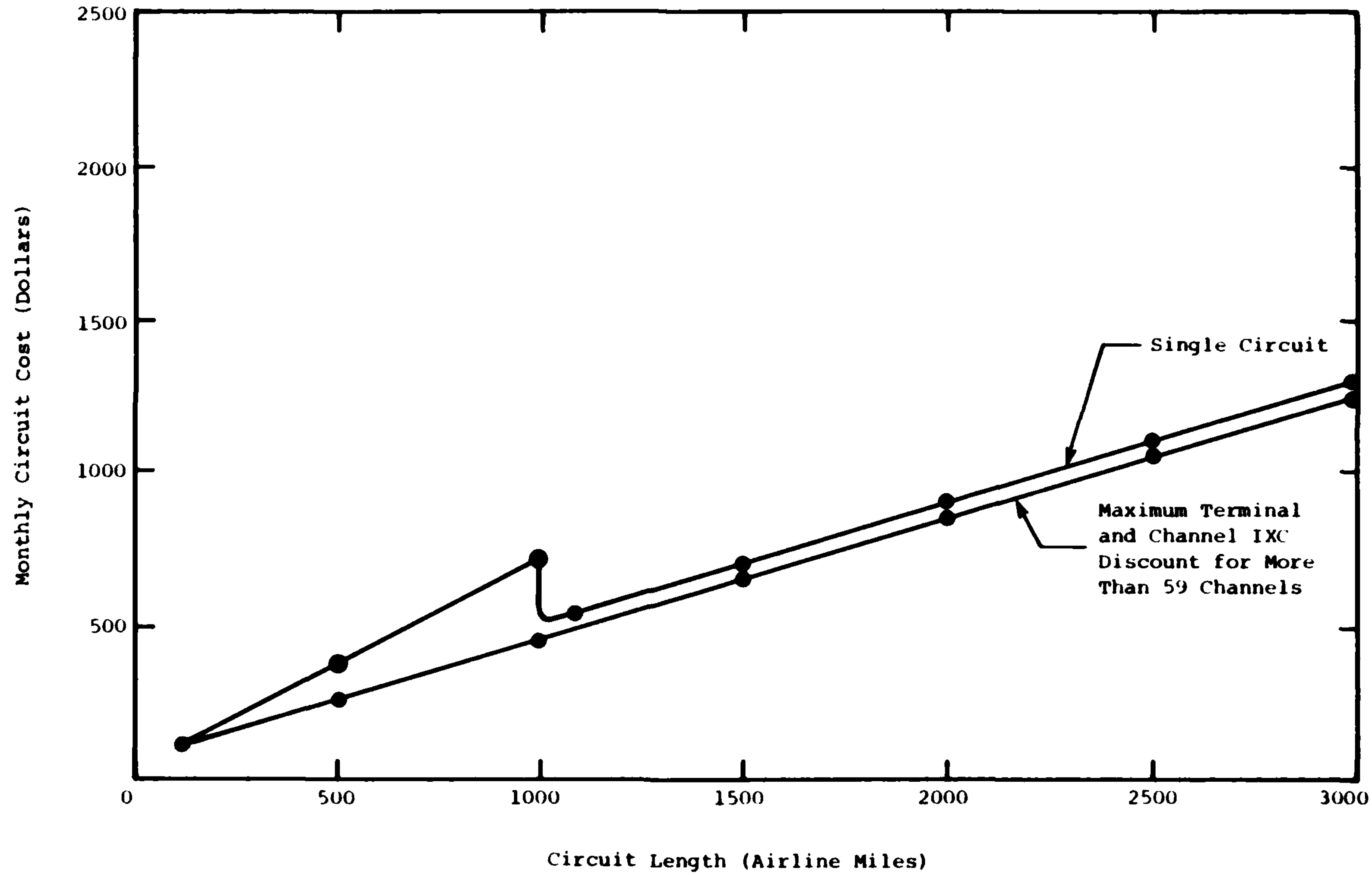

Figure *6-9.* SPCC PRIVATE-LINE SERVICE, SPCC TARIFF NUMBER TWO

Table 6-25. SPCC MILEAGE CHARGES FOR MEDIUM-SPEED CHANNELS			
Miles	Charge per Mile per Month (Dollars)		
	30-day Service Commitment	60-day Service Commitment	2-year Service Commitment
0-50	0.70	0.60	0.60
51-250	0.697 to 0.565	0.593 to 0.472	0.599 to 0.460
251-750	0.565 to 0.447	0.472 to 0.401	0.460 to 0.388
751-3,000	0.447 to 0.395	0.401 to 0.365	0.388 to 0.356

discounts associated with circuit mileage and number of terminals. Discounts are based on the number of channels and terminals leased by a subscriber. This type of pricing structure provides for an extent of discount based upon quantity leased. The discounts range up to 82 percent, depending upon circuit length and number of channels and terminals. SPCC terminal charges for data and voice-grade circuits are shown in Table 6-26.

Local access channels for SPCC service are provided between the carrier's operating center and the subscriber's premises. The charges for this service element are given in Table 6-27.

Partial period-scheduled metered time

SPCC's option of partial period-scheduled metered time provides a metered-use voice-grade private-line offering for subscribers having limited requirements or a need to address full-time channel group overflows economically. Rates for the service are based on customer use during an eight-hour scheduled period of operation. Channel-termination and local distribution charges are not applicable. Rates for circuit mileage up to 750 miles are shown in Table 6-28. There is a fixed monthly minimum-use charge based on the hourly rates.

Cost Trends for SPCC private-line offering

The CTC-PAM elements that constitute the SPCC private-line service are listed in Table 6-29. Note that the first five elements of Table 6-29 reflect AT&T costs associated with local distribution from the SPCC operating center to the subscriber's premises.

Figure 6-10 depicts the CTC-PAM cost trends for SPCC's private-line service. Since SPCC's facilities are constructed with new technology, it is expected that the carrier will operate efficiently and not require extensive modernization to maintain current service levels and offer new features. Table 6-30 shows the inflation rates associated with the three SPCC private line scenarios.

Table 6-26. SPCC CHANNEL TERMINATION CHARGES	
Circuit Type	Monthly Rate (Dollars)
75 bps	23.00
75-300 bps	23.00
600-9600 bps C-2 conditioned voice-grade circuit (2 point, 4000 Hz)	33.00
1-20 Terminals per City	33.00
21-40 Terminals per City	29.00
41-60 Terminals per City	25.00
61 or more Terminals per City	23.00

Table 6-27. SPCC LOCAL ACCESS CHANNEL CHARGES	
Type of Channel	Monthly Charge (Dollars)
Within SPCC local distribution area	
1-29 Voice terminations per premises	32.00 + 1.00 per mile
20-30 Voice terminations per premises	32.00
31-40 Voice terminations per premises	30.00
41 or more Voice terminations per premises	24.00
Outside local distribution area	Actual cost + 5 percent
Additional station, same premises	2.00
Termination at CCSA switches or open end of FX	10.00

Table 6-28. CHARGES FOR SPCC SCHEDULED METERED-TIME PRIVATE-LINE SERVICE

Mileage Band	Daytime		Nighttime	
	Monthly Minimum Miles	Hourly Rate (Dollars)	Monthly Minimum Miles	Hourly Rate (Dollars)
0-250	210	6.00	200	6.50
251-500	250	8.00	240	8.00
501-750	350	12.00	320	8.00

Table 6-29. CTC-PAM ELEMENTS CONSTITUTING SPCC PRIVATE LINE SERVICE

Elements	Number of Units	Cost Symbol
Terminals	2	BTE or KTE
Terminal Wiring - Business	2	TWBE
Access Line - Business	2	ALPL
Access Line - Voice-Conducting Line	2	ALVP
Exchange Trunk - Business	2	ETBE
SPCC Intercity Multiplexer	1	SMUX
SPCC Circuit Signaling	1	SCKTS
SPCC Intercity Line-Haul	1	SHL

As shown in Table 6-31, the worst-case, best-case, and expected-case scenarios produced CTC-PAM short-term (1987) and long-term (1994) service inflation expectancies and associated short-term compound inflation rates. The trend analysis indicates that the cost of service will increase about 40 to 60 percent over the next 7 years and will double over the next 15 years. The compound annual inflation rate is expected to be in the range of 5 to 7 percent per year over the short term. It is expected that these trends will hold for all of SPCC's transmission-intensive services.

6.2.2.2 SPCC Switched Private Network Telecommunications (SPRINT)

SPRINT has been offered by SPCC since 1976; it is designed to provide switched interstate communication facilities for voice or data transmission

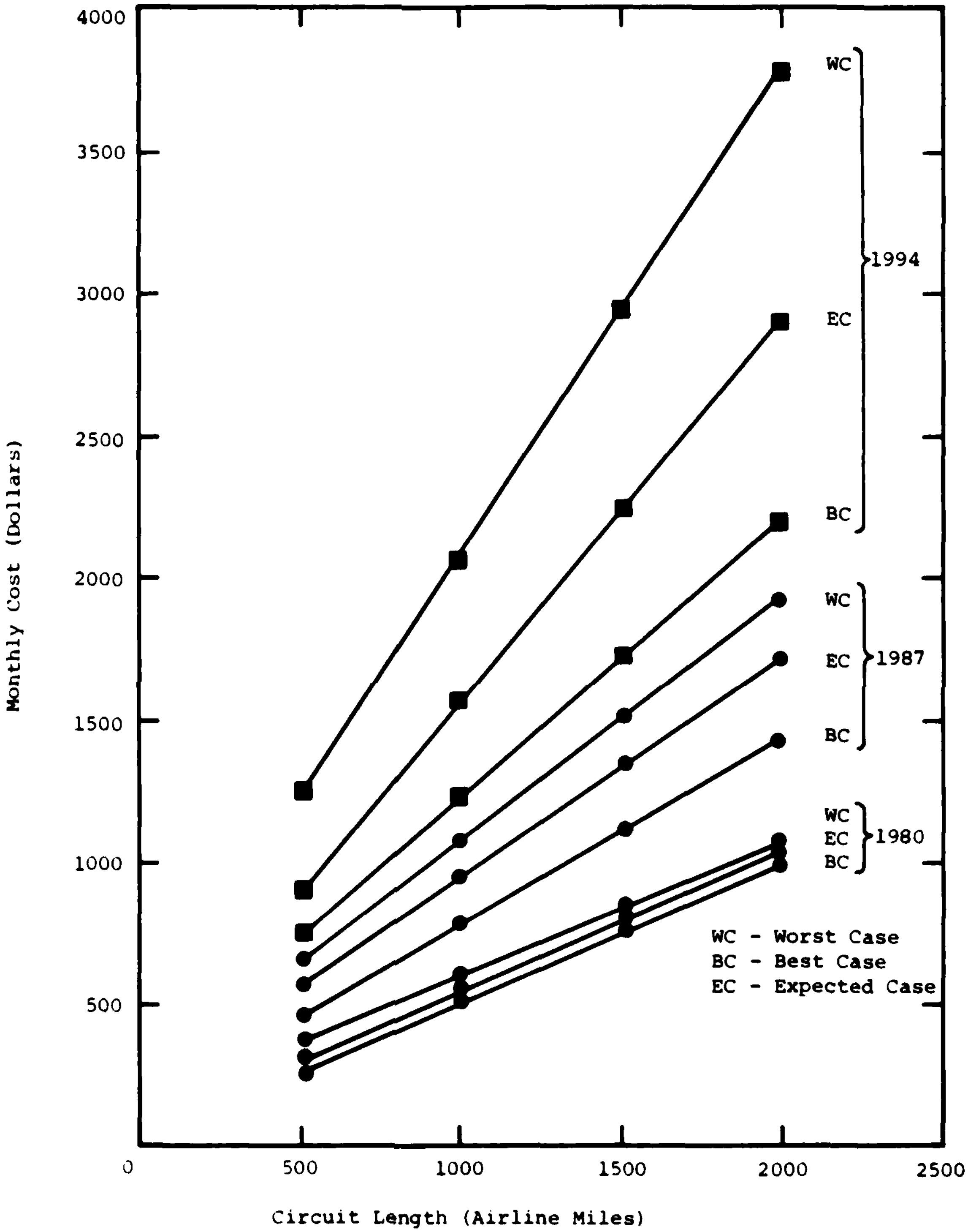

Figure 6-10. SPCC PRIVATE-LINE SERVICE COST TRENDS FOR THREE SCENARIOS AND VARYING CIRCUIT LENGTHS

Table 6-30. INFLATION RATES ASSOCIATED WITH SPCC'S PRIVATE LINE SERVICE		
Scenario	Equipment Inflation Rate (Percentage)	Maintenance Inflation Rate (Percentage)
Worst Case	5	12
Best Case	1	8
Expected Case	3	8 to 10

Table 6-31. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR SPCC'S PRIVATE LINE SERVICE			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.9	3.66	9.6
Best Case	1.4	2.1	4.9
Expected Case	1.6 to 1.4	2.8 to 2.1	7.21 to 4.9

between assigned city pairs. The offering consists of five different types of services or options that differ in access method and pricing structure. These services are similar to AT&T's IN-WATS, OUT-WATS and foreign exchange offerings. The five SPRINT options are available in more than 20 metropolitan areas, and several of these options are offered in an additional 40 cities. The five SPRINT configurations are the following:

- SPRINT I. This is a dedicated point-to-point "hot line" type of service.
- SPRINT II. This service provides a dedicated access line at the closed end of the circuit and a telephone company business trunk at the other end; it is thus equivalent to foreign exchange service.
- SPRINT III. This is the same as SPRINT II, except that service is restricted to inbound calls (and is thus equivalent to IN-WATS).
- SPRINT IV. This service is restricted to outward calls. Access at the subscriber (or closed) end is through a dedicated access line, and access at the other service end is through the public telephone network. (This service is equivalent to OUT-WATS.)
- SPRINT V. Access to this service is through the public telephone network. The customer must lease at least one authorization code. The service is called "IN-SPRINT" when used only for inward calls.

The SPRINT rates are made up of a network access charge (where applicable) and a usage charge metered in tenths of a minute. In addition, monthly minimums apply to some options. Table 6-32 gives typical SPRINT rates based on mileage, type of service, and time of day.

Table 6-32. SPRINT RATES

SPRINT I-IV Rates (Dollars)			SPRINT V Rates (Dollars)		
Miles	Day Rates (Dollars)	Night Rates (Dollars)	Miles	Day Rates (Dollars)	Night Rates (Dollars)
1-100	0.1541	0.0816	1-124	0.23	0.0805
101-200	0.1557	0.0832	125-196	0.240	0.0840
201-300	0.1573	0.0848	197-292	0.250	0.0875
301-400	0.1587	0.0864	293-430	0.265	0.0928
401-500	0.1605	0.0880	431-925	0.285	0.0998
501-600	0.1621	0.0895	926-1910	0.315	0.1103
701 and over	0.0016 per 100 miles				

The elements that constitute the SPRINT service in the CTC-PAM cost trending are listed in Table 6-33.

A number of the elements reflect AT&T costs, since the service contains both OCC- and Bell-provided transmission. In addition, an exchange network facility for interstate access (ENFIA) is required; this provides (1) a Bell center office connecting facility between the OCC terminal location and the telephone company central office, (2) local switching, (3) trunking, and (4) the use of jointly owned subscriber plant. The ENFIA cost element comprises a total of seven Bell elements and is computed as a separate service by the CTC-PAM. Table 6-34 depicts the short-term, long-term, and compound inflation factors for SPCC's SPRINT services. The expected short-term service compound inflation rate is 5 percent. Rates are expected to double by 1994, given an overall inflation level of about 10 percent, and an increase of approximately 40 percent is expected over the next seven years.

6.2.3 Trends in MCI Service Offerings

After the FCC's 1969 decision on specialized common carriers, MCI rapidly expanded to a book value of $80 million, with more than 40 cities in its network. At present MCI provides leased full- or partial-period point-to-point transmission, measured-use point-to-point switched, and common

Table 6-33. CTC-PAM ELEMENTS CONSTITUTING SPRINT		
Element	Number of Units	Cost Symbol
SPCC Intercity Line-Haul (calculated at a SPRINT mean of 240.0 miles)	1	SLHC
SPRINT Terminal Equipment	1	STES
SPRINT Network Switching Facility		SNSF
Terminals - Business	2	BTE, RTE
Access Line Wire -- Private Line		AEPL
Terminal Wire - Business	2	TWBE
Access Line Voice Conduction	2	ALVE
Exchange Trunks -- Private Line	2	ETPL
Intercity Line-Haul	1	LHPL
End-Terminal Multiplexer	2	EMPL
Intermediate Terminal Multiplexer	1	IMPL
Bell ENFIA OCC Interconnect Facilities	1	ENFIA

Table 6-34. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR SPRINT			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Expected Case	1.42	2.1	5.0
Worst Case	2.0	3.6	9.5
Best Case	1.4	2.0	4.8

control switching (CCS) services to major metropolitan areas in the United States. MCI is best characterized as a company that will aggressively pursue new services, new customers, and innovation, and will fearlessly challenge AT&T and the FCC in the courts. Its services offer substantial discounts to the heavy user and innovative pricing features, and its shared private-line service allows low-volume users to share private-line facilities economically. In this study we performed trend analyses for MCI's private-line service, Quickline/EXECUNET, and CCSA services.

6.2.3.1 Private-Line Services

The structure of MCI's private-line tariff is based on the total channel mileage leased by a customer and the number of channel ends provided. The cost per mile of a customer's network decreases as the size of his network increases.

Figure 6-11 shows the MCI rate structure and the effect of service discounts on circuit cost. MCI's discounts range from 33.5 percent for a small number of leased circuits to 57.9 percent, which applies when there are a large number of leased circuits. The service is offered in voice-grade channel increments of 1 to 240, each having a nominal bandwidth of 4 kHz. The MCI private-line tariff consists of two rate elements: an inter-exchange (IXC) mileage charge and a channel-termination charge. Table 6-35 illustrates the IXC rates as a function of total channels and channel miles leased. In addition to the IXC charges shown in Table 6-18, short-haul surcharges are as follows:

Mileage Interval	Monthly Charge
1 - 50 miles	$ 50.00
51 - 100 miles	30.00
101 - 225 miles	20.00

MCI also lists rates in its tariffs for city pairs that may be used if they are lower than the discounted rates calculated from Table 6-35. Data channels are discounted in accordance with the following:

Channel Rate	Percentage Discount of VF Channel Rate
75 Baud	50
150 Baud	75
300-9600 bps	No Discount

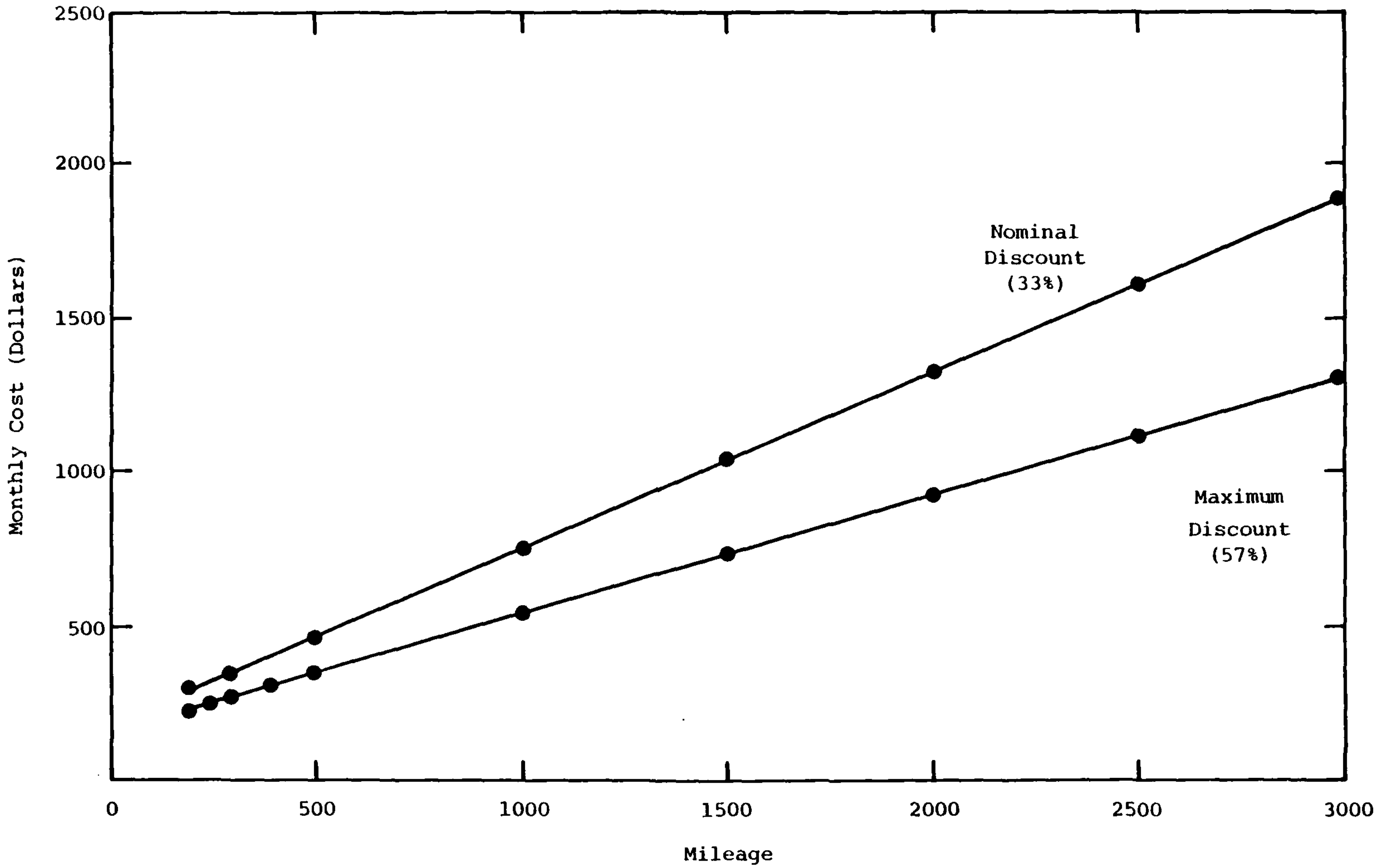

Figure 6-11. MCl PRIVATE-LINE FACILITIES -- TARIFF MC NUMBER ONE

Table 6-35. RATES OF MCI POINT-TO-POINT PRIVATE-LINE SERVICE									
Total Channel Miles (in Thousands)	Rate by Number of Channels								
	1 to 9	10 to 39	40 to 49	50 to 74	75 to 99	100 to 149	150 to 499	500 to 999	Continued
0-1	$0.88	$0.88	$0.88	$0.88	$0.88	$0.88	$0.88	$0.88	
1-5	0.88	0.88	0.75	0.74	0.73	0.71	0.71	0.71	
5-10	0.88	0.87	0.73	0.71	0.70	0.68	0.68	0.68	
10-25	0.88	0.80	0.71	0.68	0.67	0.64	0.62	0.60	
25-50	0.85	0.80	0.69	0.67	0.66	0.62	0.60	0.59	
50-75		0.76	0.68	0.66	0.65	0.60	0.57	0.57	
75-100		0.73	0.66	0.64	0.63	0.56	0.52	0.52	
100-125		0.73	0.64	0.61	0.60	0.52	0.45	0.45	
125-150		0.73	0.63	0.60	0.59	0.50	0.45	0.45	
150-175				0.59	0.58	0.49	0.44	0.44	
Continued									

Channel terminations are priced in accordance with the number of channels leased, as follows:

Number of Channels	Monthly Rate (Dollars)
1 - 21	66.00 each
22	1403.61
23 - 35	15.18 each
36	1615.68
37 - 59	33.35 each
60	2416.24
Each Additional	40.20

The CTC-PAM elements used perform the trend analysis for MCI point-to-point private-line service are listed in Table 6-36.

Table 6-36. CTC-PAM ELEMENTS FOR ANALYSIS OF MCI PRIVATE-LINE SERVICE		
Cost Element	Number of Units	Cost Symbol
Terminal	2	BTE or KTE
Terminal Wiring -- Business	2	TWBE
Access Line Wire -- Business	2	ALPL
Access Line Voice-Conducting -- Private Line	2	ALVP
Exchange Trunk -- Business	2	ETKE
MCI Intercity Multi-plexer Costs	1	MMUX
MCI Line-Haul Costs	1	MLHC

Note that several of the MCI cost elements contain Bell service charges.

Table 6-37 shows the worst-case, best-case, and expected-case scenarios used in the MCI trend analysis.

Table 6-37. INFLATION RATES ASSOCIATED WITH MCI's PRIVATE-LINE SERVICE		
Scenario	Equipment Rate (Percentage)	Maintenance Rate (Percentage)
Worst Case	5	12
Best Case	1	8
Expected Case	3	10

Like SPCC, MCI utilizes current technology, and operations are expected to maintain service levels with an effective equipment inflation rate of less than 8 percent.

Table 6-38 presents the expected service cost inflation rate for MCI's private-line service for worst-case, best-case, and expected-case scenarios.

Table 6-38. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR MCI PRIVATE-LINE SERVICE

Scenario	1987 Factor	1994 Factor	Short-Term (1987) Service Inflation Rate (Percentage)
Worst Case	1.6	2.8	7.3
Best Case	1.2	1.5	2.2
Expected Case	1.40	2.16	4.7

Figure 6-12 shows the projection of the MCI monthly costs for the 15-year study period for a 1000-mile circuit at maximum discount. The MCI cost trends are displayed differently from those for SPCC (See Figure 6-10), in order to illustrate the various ways of reflecting the results of the trend analysis.

6.2.3.2 Quickline and EXECUNET Services

In the latter part of 1974, MCI introduced a pay-as-you-go point-to-point measured-use offering, which provided low-volume users the benefits of an affordable private-line service. This offering, called Quickline service, was originally begun between New York, Washington, Chicago, and Pittsburgh, and now includes 18 cities. It paved the way for MCI's new and revolutionary EXECUNET service.

The charges for Quickline are based on a circuit termination charge and measured-use charges arranged in a graduated schedule. The rate schedule sets a fixed hourly charge of $14.235 for the first 100 miles and a per-minute charge of $0.23725 from 7 a.m. to 7 p.m.; weekend rates are 30 percent of the day rate. For circuits of more than 100 miles but less than 700 miles, $0.00911 is added to the fixed hourly rate (over 700 miles) and $0.015184 per mile is added to the per-minute rate. For circuits of more than 700 miles, the incremental cost per hour is $0.001708 per mile (over 700 miles) and $0.002846 per mile for each minute.

MCI followed its Quickline service with its EXECUNET offering, which interconnects with Bell switching exchanges and bypasses the AT&T line-haul facilities. Because the service allows customers to access alternative facilities for placing calls that were normally toll calls, an extensive regulatory and legal battle developed between MCI and AT&T. As stated earlier, MCI won its case in 1977 when a federal court of appeals reversed an FCC ruling prohibiting MCI from offering EXECUNET. At present, EXECUNET provides more than 40 percent of MCI's revenue and has more than 10,000 customers. MCI has its sights on the large interstate switched-access market and will continue to expand this service as fast as possible.

The rates for this service are composed of two elements: a metered-use charge, and a call-termination surcharge. The first rate is the same

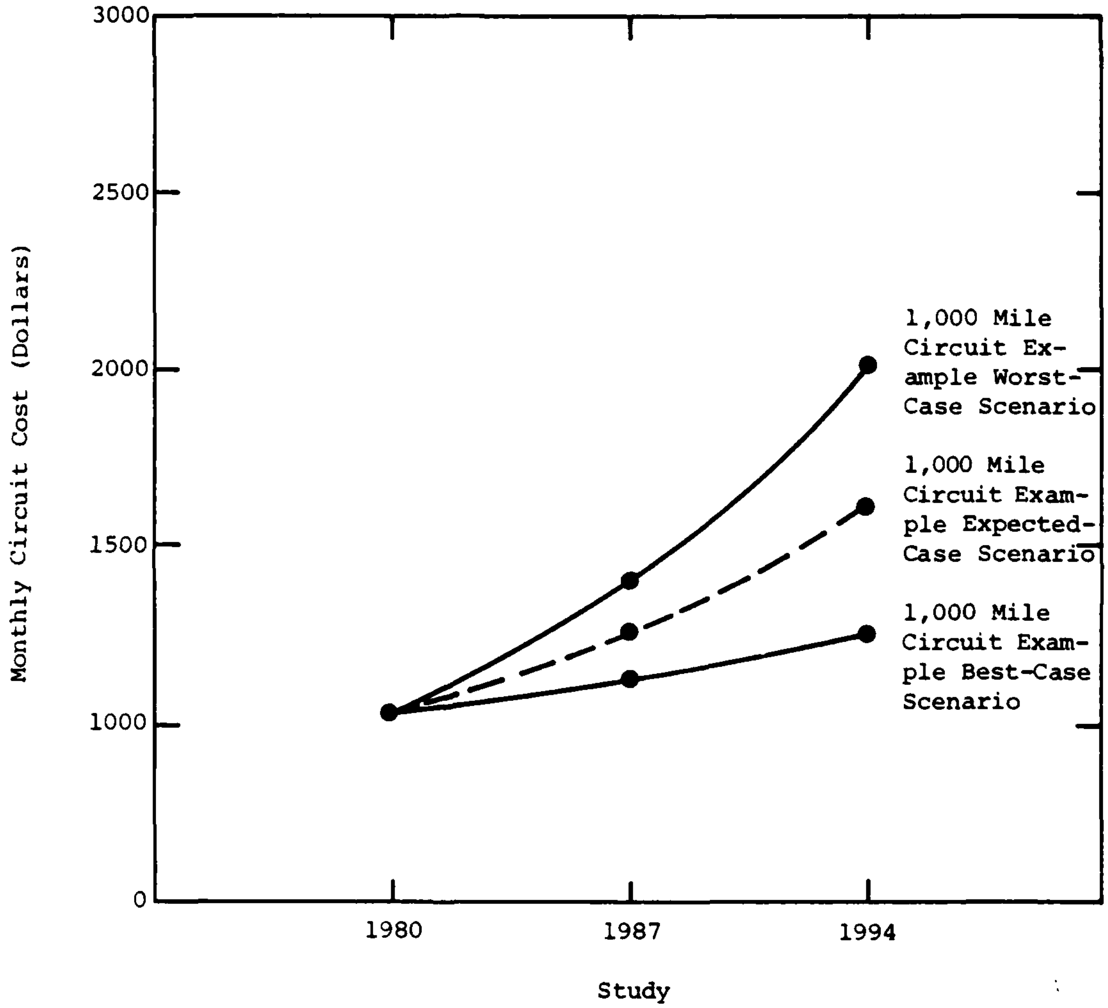

Figure 6-12. EXAMPLE OF COST TRENDS FOR A 1,000-MILE MCI CIRCUIT AND THREE FACTOR SCENARIOS

as that of Quickline, as discussed above, and the call-termination/origination surcharge is as follows:

Call origination surcharge: $0.07 per minute

Call termination surcharge: $0.027 per minute

For a customer who wants a dedicated user line similar to WATS, the EXECUNET service offered is called Network Service. The total monthly charge for Network Service is composed of three parts: (1) a metered-use charge, (2) a call-termination surcharge, and (3) a channel-termination charge.

The metered-use charge is the same as for Quickline, the call-termination surcharge is $0.027 per minute, and the channel-termination charge is the same as for Quickline. There are three types of discounts for this service:

- Rates for the 7 p.m.-7 a.m. period and the weekend are discounted 30 percent.
- A 60 percent discount is offered for 120 to 240 hours of use, and a 19 percent discount for more than 240 hours.
- For a flat rate of $75.00, a customer may apply up to 60 minutes of traffic to each of 10 MCI cities. Overflow over 60 minutes is billed at standard usage rates, and the 10 MCI cities selected by the customer are based on the cities most frequently called during a billing month.

The CTC-PAM elements that constitute SPRINT and EXECUNET are listed in Table 6-39.

Table 6-39. CTC-PAM ELEMENTS CONSTITUTING SPRINT AND EXECUNET

Element	Number of Units	Cost Symbol
MCI Intercity Line-Haul	1	MLHC
EXECUNET Terminal Equipment	1	MTES
EXECUNET Network Switching Facility	1	MNSF
Terminals - Business	2	BTE, RTE
Access Line Wire - Private Line	1	ALPL
Terminal Wire - Business	2	TWBE
Access Line Voice Conduction	2	ALVE
Exchange Trunks - Private Line	2	ETPL
Intercity Line Haul	1	LHPL
End-Terminal Multiplexer	2	EMPL
Intermediate Terminal Multiplexer	1	IMPL
Bell ENFIA OCC Interconnect Facilities	1	ENFIA

Again, a number of the MCI SPRINT/EXECUNET cost elements reflect Bell service charges. The CTC-PAM model was exercised with the worst-case, best-case, and expected-case scenarios, as given in Table 6-40.

Table 6-40. INFLATION RATES ASSOCIATED WITH MCI's PRIVATE-LINE SERVICES

Scenario	Equipment Cost Inflation Rate (Percentage)	Maintenance-Related Inflation Rate (Percentage)
Worst Case	5	12
Best Case	-1	8
Expected Case	3	10

The worst-case, best-case, and expected-case cost trends for the Quickline/EXECUNET service rates are given in Table 6-41. It is expected that these rates will increase by only 40 percent over the next 7 years and will double over the next 15 years. The short-term increase in service cost is expected (i.e., on an annual compound basis) to be on the order of 5 percent or less.

Table 6-41. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR MCI'S EXECUNET SERVICES

Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.95	3.4	10.0
Best Case	1.35	1.95	4.4
Expected Case	1.40	2.0	4.9

6.2.3.3 CCSA Service

In September 1976 MCI became the first SCC to offer common control switching arrangement (CCSA) service. This service had been offered by AT&T to large corporate private-line users. The principal purpose of MCI's offering was to serve customers having more limited communications requirements than the large corporations.

MCI's CCSA contains features designed to increase user productivity and control cost, given a mixture of subscribed services (e.g., WATS, FX, DDD). These features include the following:

- Least-cost-first routing, which automatically routes calls over the least-cost facility without user control.
- Authorization code prefix dialing, which allows information to be collected on user calling patterns and costs.
- Abbreviated dialing, in which the user dials a four-digit code and the CCSA equipment automatically adds the digits necessary for the call to be completed.
- Tone notification, which notifies the user by tone that the call is not going to be routed on the most cost-effective facilities.

The total monthly charge for MCI's CCSA comprises access line termination charges and service option charges. Access channel and intercity private-line rates associated with interswitch trunks are separate from the CCSA rates. MCI's CCSA rates are summarized in Table 6-42.

Table 6-42. MCI'S CCSA SERVICE RATES

Service Element	Monthly Charge (Dollars)
1. Port Charges	
• Port Charge for Least-Cost Routing (LRC) Version (gives only call detail features)	35
• Port Charge for Full Service	160
2. Options	
• Call Traffic Sorts by Destination	20
• Area Code Traffic Summary	25
• Area Code Traffic Call Detail	30
• Summary of Call Authorization Accounting Codes	20
• Call Records on Magnetic Tape	20

The CTC-PAM elements used to perform the trend analysis for MCI's CCSA services are listed in Table 6-43.

Table 6-43. CTC-PAM ELEMENTS FOR TREND ANALYSIS FOR MCI's CCSA

Cost Element	Number of Circuits	Cost Symbol
Electronic Switch Port (Basic)	1	MCCSL
Electronic Switch Port (Full Service)	1	MCCSF
Call Traffic Sort Feature	1	MCTS
Area Code Traffic Summary	1	MACTS
Area Code Traffic Call Detail	1	MACTD
Summary of Call Authorization/ Accounting Codes	1	MSCAC
Call Records on a Magnetic Tape	1	MCRMT

Table 6-44 gives the inflation rates used for the two cost components of the CCSA service for worst-case, best-case, and expected-case scenarios.

Table 6-44. INFLATION RATES ASSOCIATED WITH MCI'S CCSA SERVICE

Scenario	Equipment Cost Unflation Rate (Percentage)	Operating Cost Inflation Rate (Percentage)
Worst Case	5	12
Expected Case	3	10
Best Case	1	8

Table 6-45 summarizes the CTC-PAM short-term and long-term service inflation expectancies for the worst-case, best-case, and expected-case scenarios. The rates are expected to increase about 57 percent over the next seven years, an increase that gives a compound annual inflation rate of 6.8 percent.

Table 6-45. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR MCI'S CCSA SERVICE			
Scenario	1987 Factor	1994 Factor	Short Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.73	3.7	8.1
Expected Case	1.57	2.91	6.8
Best Case	1.428	2.3	5.2

6.2.4 Trends in RCA Satellite Service Offerings

RCA Global Communications (RCA Globcom) and RCA Alaska Communications (RCA Alascom) were the first to offer commercial satellite services in the United States. Service was initiated in the United States when RCA started leasing circuits on the Telsat ANIK II satellite in 1973. RCA Globcom is an international voice/record carrier, and RCA Alascom is the authorized long-lines carrier for Alaska. As directed by the FCC, RCA separated its domestic satellite service into a separate entity called RCA American Communications, Inc. (RCA Americom).

In December 1975 and March 1976, RCA launched Satcom I and II, which were designed and built at RCA's ASTRO Electronics Division, Princeton, New Jersey. Major earth stations are operated near New York City, Chicago, Philadelphia, Los Angeles, San Francisco, Atlanta, and Houston. More than 750 earth stations now receive or transmit voice, data, or television traffic by RCA satellite. Most stations using the RCA service are customer-owned.

RCA offers point-to-point communication channels for voice, data, facsimile, and various wideband applications. These services are furnished by a combination of conventional land-line facilities and satellite links. Rates are a composite of three rate elements: (1) satellite channel charge, (2) channel termination charge, and (3) local access facility. Table 6-46 lists the monthly satellite channel charge for all RCA service locations, and the airline miles and calculated channel cost per airline mile for comparison with other vendor interexchange (IXC) rates. The satellite service IXC rates are lower than AT&T private-line rates (e.g., the average IXC rate for San Francisco to Chicago is $0.60 per mile for MPL and $0.40 per mile for RCA) and are becoming more widely accepted for long-haul voice and data use. Channel termination charges (the second rate element) are based on total number of channels leased, as follows:

1 to 11 channels:	$25.00 per end
12 to 23 channels:	$20.00 per end
24 or more channels:	$17.50 per end

The third rate element, local access facilities, provides local access to the RCA operating center. The rates are as follows:

- Within designated local exchange area — $25.00 per month
- Outside designated local exchange area, up to 30 miles — $ 6.50 per month + $ 4.00 per mile

Table 6-46. RCA VOICE-GRADE CHANNEL RATES

City Pair		Channel Monthly Rate (Dollars)	Airline Miles	Channel Cost Per Airline Mile (Dollars)
Chicago	Atlanta	500	586	0.85
Chicago	Camden	500	666	0.75
Dallas	Camden	750	1,296	0.59
Dallas	Chicago	500	799	0.63
Houston	Camden	750	1,340	0.56
Houston	Chicago	500	935	0.53
Los Angeles	Camden	1,000	2,387	0.42
Los Angeles	Chicago	750	1,739	0.43
Los Angeles	Dallas	600	1,241	0.48
Los Angeles	Houston	700	1,376	0.51
New York	Chicago	500	712	0.70
New York	Dallas	600	1,369	0.44
New York	Houston	700	1,417	0.49
New York	Los Angeles	1,000	2,443	0.41
San Francisco	Camden	1,000	2,516	0.40
San Francisco	Chicago	750	1,852	0.40
San Francisco	Dallas	700	1,482	0.47
San Francisco	Houston	700	1,646	0.43
San Francisco	New York	1,000	2,564	0.39
Washington	Chicago	700	595	1.18
Washington	Houston	900	1,217	0.74
Washington	Los Angeles	1,000	2,292	0.44
Washington	San Francisco	1,000	2,433	0.41
Wilmington	Chicago	650	648	1.00
Wilmington	Houston	900	1,314	0.68
Wilmington	Los Angeles	1,000	2,366	0.42
Wilmington	San Francisco	1,000	2,497	0.40

As of 17 March 1980 RCA has filed new wholesale rates, which offer three types of circuit densities at rates ranging from $400.00 to $470.00 per month. The first type of service requires a minimum of 60 circuits to be leased for a minimum of one year. The second and third types require a minimum of 2,500 and 3,000 circuits, respectively, to be leased for a minimum of three and five years, respectively. This type of pricing will probably become increasingly popular in the satellite service area, since

this pricing will encourage higher levels of transponder capacity use as a result of the attractive price and reduced circuit turnover.

The CTC-PAM elements used to perform the analysis of cost trends for RCA's private-line satellite service are listed in Table 6-47.

Table 6-47. CTC-PAM ELEMENTS USED FOR RCA ANALYSIS

Cost Elements	Number of Units	Cost Symbol
Telephone Terminals	2	BTE or RTE
Terminal Wiring - Business	2	TWBE
Access Line Wire - Business	2	ALPL
Access Line - Voice Conducting Private Line	2	ALVP
Exchange Trunk - Business	2	ETBE
RCA Earth Terminal Channel Element	2	RCAET
RCA Space Link	1	RCASL

Note that the first five elements are AT&T cost components associated with local distribution from RCA's operating center to the customer's premises.

Table 6-48 depicts the equipment and operating cost (maintenance) inflation rates for the worst-case, best-case, and expected-case scenarios. The CTC-PAM model was exercised with these scenarios, and cost trends were analyzed over the study period. Figure 6-13 depicts the monthly cost of a 1,000-mile circuit from 1980 to 1994 for the three scenarios. As indicated, satellite service costs are expected to increase 18 percent and 46 percent over the next 7 and 15 years, respectively. As indicated in Table 6-49, the service is expected to exhibit a short-term annual compound inflation rate of 3.1 percent. Compared with other offerings, these service inflation factors provide a strong indication that satellite services will be relatively stable and relatively resistant to the effects of inflation over both short- and long-term periods. This cost stability results from the space link's requirement of relatively fixed capital-related costs as compared with other transmission methods (e.g., microwave radio and coaxial cable), which require extensive maintenance activity. As 1994 approaches, the ratio of space link monthly cost to the total monthly cost per channel goes from 42 percent to 23 percent. This phenomenon illustrates the cost volatility of the earth terminal, local distribution, and terminal equipment with respect to the space link.

Table 6-48. INFLATION RATES ASSOCIATED WITH RCA'S PRIVATE-LINE SATELLITE SERVICE		
Scenario	Equipment Cost Inflation (Percentage)	Operating Cost Inflation (Percentage)
Worst Case	5	12
Expected Case	3	10
Best Case	1	8

Table 6-49. SHORT- AND LONG-TERM INFLATION FACTORS FOR RCA'S PRIVATE-LINE SATELLITE SERVICE			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.3	1.808	3.7
Expected Case	1.8	1.46	3.1
Best Case	1.6	1.5	2.4

6.2.5 Trends in Costs of Western Union Services

Western Union offers private-link transmission facilities under three major tariffs:

- Tariff No. 254, Series 2000 and 3000 Multischedule Private-Line (MPL) Service
- Tariff No. 254, Series 5000 (Telpak) Interstate Private-Line Service
- Tariff No. 261, Satellite Service

Western Union's Series 2000 and 3000 MPL and Series 5000 Telpak are exactly the same as AT&T's MPL and Telpak tariffs, discussed in Section 6.2.1. WU's MPL coverage of Category A cities is not as extensive as AT&T's; however, its coverage of A cities has been expanding.

It is expected that WU's MPL and Telpak tariffs will mirror any changes that AT&T's equivalent services will undergo, since WU is effectively a concurring carrier. These changes would include changes in tariff forms

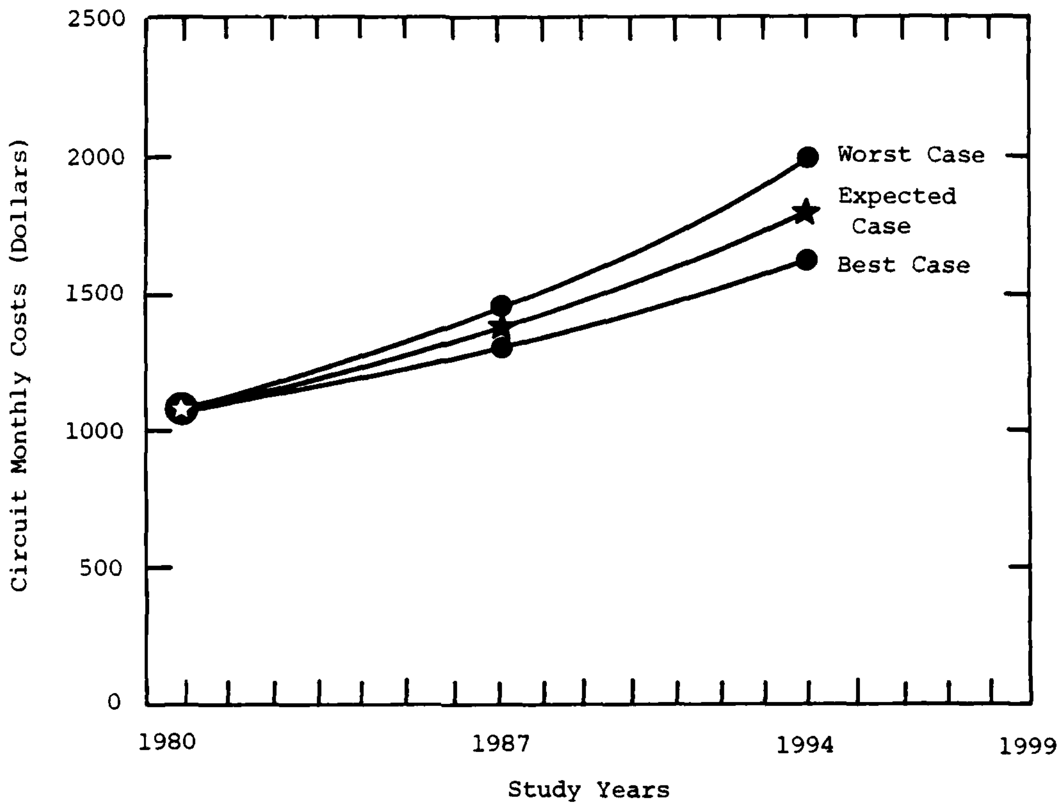

Figure 6-13. TRENDS IN RCA SATELLITE COSTS (1,000-MILE CIRCUIT)

and rates due to rate cases or regulatory proceedings such as the private-line restructurings described earlier (Docket 79-246). Thus, we consider the AT&T private-line transmission trend analysis and economic service inflation factors appropriate for WU rate projections. We do not expect WU to depart from its tariff alliance, because many of its customers are used to the AT&T appearance of the service and associated tariffs. We do expect WU to offer a variety of new services (including data processing), which will bring additional revenue from its subscribers.

As stated earlier, we selected WU to be studied as a satellite carrier together with RCA. WU's domestic satellite service commenced in April 1974, when WESTAR I was launched into orbit. Shortly thereafter WESTAR II was placed in orbit to augment service capacities. A liberal interconnection policy was established, which allowed direct connection to other carriers and customer-provided facilities. This policy was designed to foster the use of satellite facilities.

WESTAR transmission services are priced according to a three-zone mileage structure as follows:

Zone	Mileage Range	Monthly Rate (Dollars)
1	Up to 1075	500
2	Up to 1875	750
3	1876 and more	1000

Discounts offered to users are based on total channels leased independent of service locations, as follows:

Number of Channels	Discount (Percentage)
6 to 11	10
12 to 23	20
24 to 59	30
60 to 239	35
240 and more	45

Two types of terminations and associated charges are required. The first is a channel termination charge of $20 per month per voice-grade channel per access city. The second is a station termination charge for each voice-grade channel end, which is $25 per month.

Wideband channels are also offered, in increments of 48, 240, and 1.2 MHz bandwidths, and are generally leased by large business and industrial users.

The CTC-PAM uses the cost elements presented in Table 6-50 to construct the cost of providing satellite service.

Table 6-51 shows the inflation rates associated with WU's satellite service for worst-case, best-case, and expected-case scenarios. Table 6-52 shows the short-term and long-term inflation factors for the service. As indicated, cost of service is expected to increase by 30 percent and 50 percent by 1987 and 1994, respectively, and the short-term (1987) compound inflation rate is expected to be 3.1 percent.

6.2.6 Trends in Costs of Leased End-Terminal Facilities

In this portion of the study we analyzed the cost trends of switching and earth terminal equipment for possible DCA procurement, because no common carriers supply an electronic or a digital Class 4 voice switched network, though a number of manufacturers are producing these systems. Another reason was that DCA may choose to lease earth terminals and transponders to satisfy its satellite communications requirements.

Table 6-50. CTC-PAM ELEMENTS FOR WESTERN UNION SATELLITE SERVICE COSTS		
Element	Quantity	Symbol
Basic Terminal	2	BTE
Terminal Inside Wiring -- Business	2	TWBE
Private Line Voice Access Wire	2	ALPL
Private Line Access Equipment -- Voice	2	ALVE
Exchange Trunk -- Business	2	ETRB
Access Line Voice Conducting -- Private Line	2	ALVP
Western Union Satellite Link	1	SLINK
Western Union Earth Terminal	1	ETERM

Table 6-51. INFLATION RATES ASSOCIATED WITH WU'S SATELLITE SERVICE		
Scenario	Equipment Cost Inflation Rate (Percentage)	Operating Cost Inflation Rate (Percentage)
Worst Case	5	12
Expected Case	3	10
Best Case	1	8

Table 6-52. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR WU'S SATELLITE SERVICE			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.6	1.808	3.7
Best Case	1.2	1.47	2.4
Expected Case	1.3	1.5	3.1

We surveyed equipment manufacturers (exclusive of Bell) to determine costs of switching equipment and earth terminals, and we included those costs in the CTC-PAM data base for trend analysis of lease rates. A summary of our findings follows.

6.2.6.1 Switching Systems

Table 6-53 lists the manufacturers that were surveyed and the type of switching equipment that they offered. Western Electric was not included, because its equipment is not available to interconnect firms and non-Bell carriers.

Table 6-53. SUMMARY OF SWITCHING EQUIPMENT SURVEY

Manufacturer	PBX Up to 500 Lines and Trunks	PBX Up to 1000 Lines and Trunks	Class 4 Tandem Switching	Class 4/5 Local and Tandem Switching	Class 5 Local Switching
GTE Automatic Electric	GTD 1000	GTD 1000	GTD-4600 No. 2 EAX	GTD-4600 GTD-1000 No. 2 EAX	GTD-4600 No. 2 EAX
WESCOM	5805	580 L			
ROLM	MCBX	LCBX II VLCBX		MCBX/VLCBX	VLCBX
DANRAY		CBX 2000/ 4000	CTS/RSS	CBX 2000	CBX 4000/ 8000
NEC America		NEAX-31			
Northern Telecom				SL-1	SL-1
Collins			DTS		

The CTC-PAM contains the following switching analysis service capabilities:

- Node switching for less than 500 lines and trunks.
- Node switching for 500 to 1000 lines and trunks. This option allows us to consider a Class 4/5 or Class 4 application.
- Tandem switching node.

The CTC-PAM service elements for the under-500 lines and terminal service are presented in Table 6-54.

To project the lease-cost trend associated with PBXs, we exercised the model for various line and trunk sizes and calculated average costs per line. Table 6-55 shows the worst-case, best-case, and expected-case scenarios associated with our analysis. Figure 6-14 depicts the cost of a PBX equipped with 400 lines, 80 trunks, 2 operator positions, and advanced software features. As illustrated, the system costs for 1980 are approxi-

mately $7,500.00 per month. By 1987 the expected cost will be $11,000 per month, a 46.7 percent increase. By 1994 the monthly cost will have increased 206.7 percent. Table 6-56 summarizes the short-term and long-term results of the factor scenarios. As indicated, the leased PBX system is expected to have a short-term (1987) compound inflation rate of 5.6 percent.

Table 6-54. SWITCH ELEMENTS (MEDIUM SIZE)

Element	Number of Units	Symbol
Common Equipment	1	CEQUIP
Operator Positions	0 to 5	COPPOS
Common Equipment, Enhanced Feature Software (Tandem and Specialized Features)	0 or 1	CSOFTW
Trunks (Network)	0 to 200	CTKS
Access Lines	0 to 400	CLINES

Table 6-55. INFLATION RATES ASSOCIATED WITH LEASED PBX EQUIPMENT

Scenario	Equipment Cost Inflation (Percentage)	Installation Cost Inflation (Percentage)	Operating Cost Inflation (Percentage)
Worst Case	4	9	12
Best Case	0	5	8
Expected Case	2	7	10

Table 6-56. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR LEASED PBX EQUIPMENT

Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percentage)
Worst Case	1.697	2.934	7.8
Best Case	1.253	1.670	3.3
Expected Case	1.460	2.219	5.6

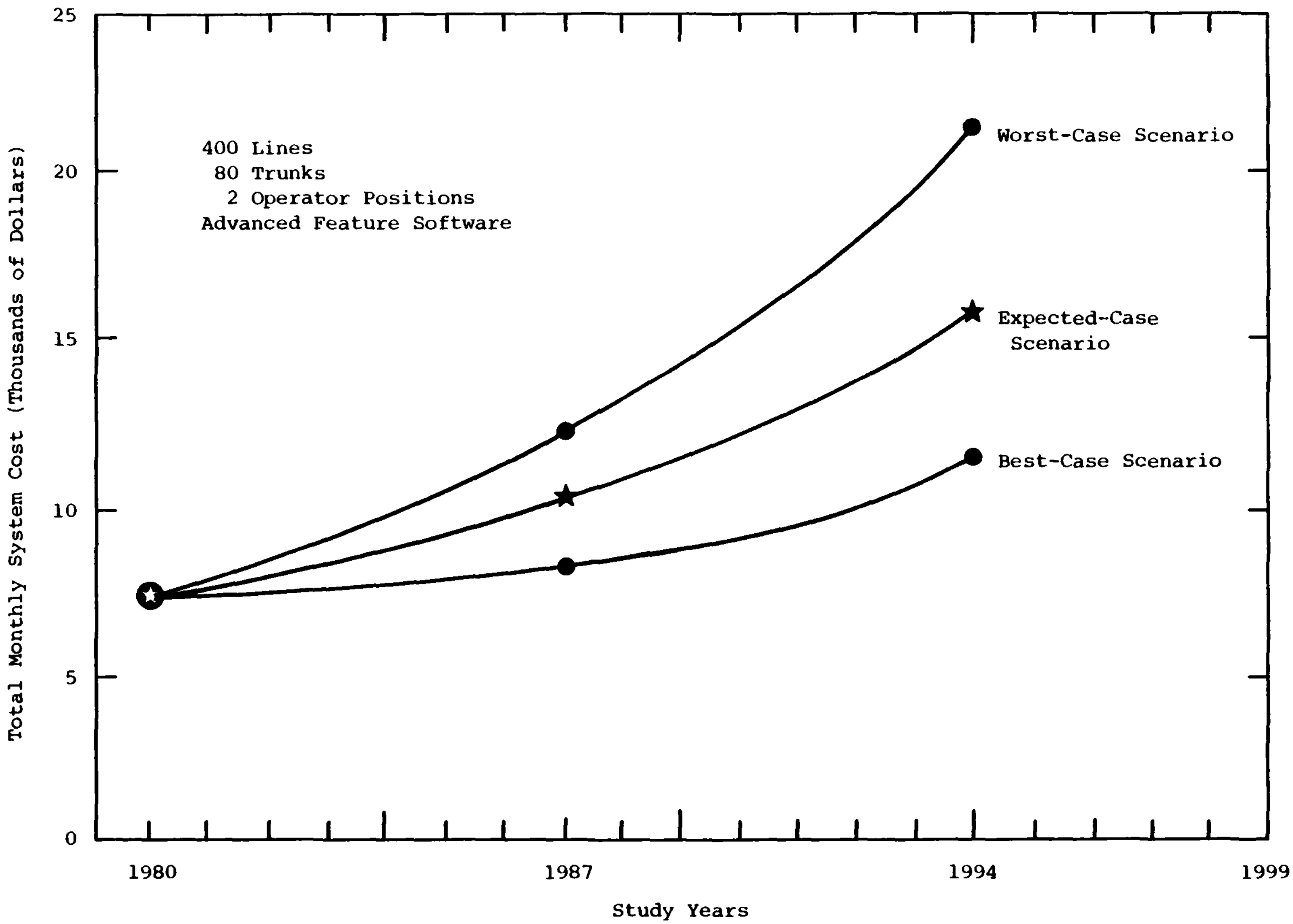

Figure 6-14. COST TRENDS FOR LEASED MEDIUM-SIZED PBX EQUIPMENT

The CTC-PAM service elements for PBX equipment over 500 lines and under 1,000 lines for Class 4/5 operation (i.e., both local and tandem switching) are shown in Table 6-57.

Table 6-57. SWITCH ELEMENTS (LARGE SIZE)

Element	Number of Units	Symbol
Common Equipment	1	CEQUIP
Special Local Feature Software	0 or 1	CSOFTA
Advanced Network Feature Software	0 or 1	CSOFTN
Trunks		
• Type A (High Usage)	0 to 400	CTKA
• Type B (Local)	0 to 400	CTKB
• Type C (Four-Wire Intermachine)	0 to 400	CTKC
Access Lines	0 to 800	CLINES
Operator Positions	0 to 8	COPPOS

The specifications for the large PBX are as follows:

- Lines = 800
- Trunks = 800 Type B
- Operator Positions = 2
- Special Local Feature Software

The CTC-PAM model was exercised with the scenario inflation rates given in Table 6-56, and the cost trends are plotted in Figure 6-15. As the figure shows, the expected 1980 monthly cost is $15,570 and the 1987 monthly cost increases to $22,611, a 45.5 percent increase over a 7-year period. The monthly cost in 1994 is expected to be $34,121, a 119.1 percent increase over the 1980 cost. A summary of short-term and long-term inflation factors and short-term (1987) compound inflation rates is given in Table 6-58. As indicated, the short-term (1987) compound inflation rate expectancy is 5.5 percent for the large PBX.

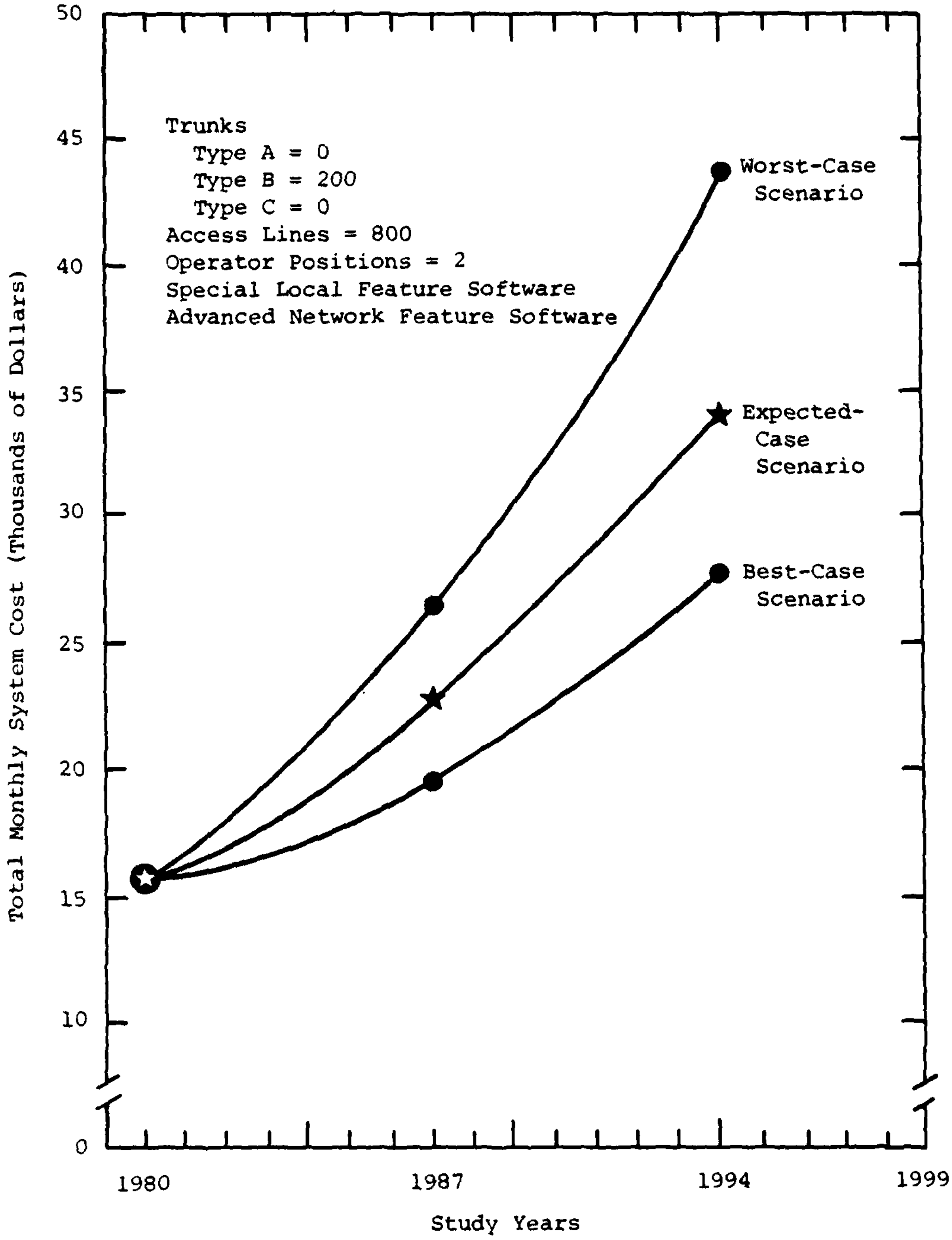

Figure 6-15. COST TRENDS FOR LEASED LARGE PBX EQUIPMENT

Table 6-58. SHORT AND LONG-TERM INFLATION FACTORS FOR LEASED LARGE PBX EQUIPMENT			
Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percent)
Worst Case	1.656	2.844	7.5
Best Case	1.270	1.680	3.5
Expected Case	1.452	2.191	5.5

To develop cost trends for tandem switching, the CTC-PAM was exercised with the scenario inflation rates given in Table 6-58. The specifications for the tandem machine are as follows:

- Access lines = 50
- Trunks
  - Type A (High Usage) = 20
  - Type B (Local) = 80
  - Type C (Four-Wire Intermachine) = 200
- Special Local Feature Software
- Advanced Network Feature Software
- Operator Positions = 0

Figure 6-16 shows the cost trends for the tandem switching node. As shown, the current monthly cost is approximately $7,000. In 1987 the expected monthly cost is $10,228, a 46.2 percent increase. The monthly cost is expected to increase by 1994 to $15,503, an increase of 121.6 percent. A summary of short-term and long-term inflation factors and the short-term (1987) inflation rates for the worst-case, best-case, and expected-case scenarios is given in Table 6-59.

6.2.6.2 Earth Station Cost Trends

DCA has an option to provide trunk and private-line requirements for high-density routes (circuits longer than 1,000 miles) through the lease of satellite transponders and earth terminals. The lease and operation of an earth terminal may or may not be through a carrier; however, the lease through a carrier is the most probable outcome, given the following alternatives:

- Government ownership and operation of the earth terminal
- Government lease and contractor operation of the earth terminal
- Government ownership and contractor operation of the earth terminal
- Leasing of carrier-owned earth terminals

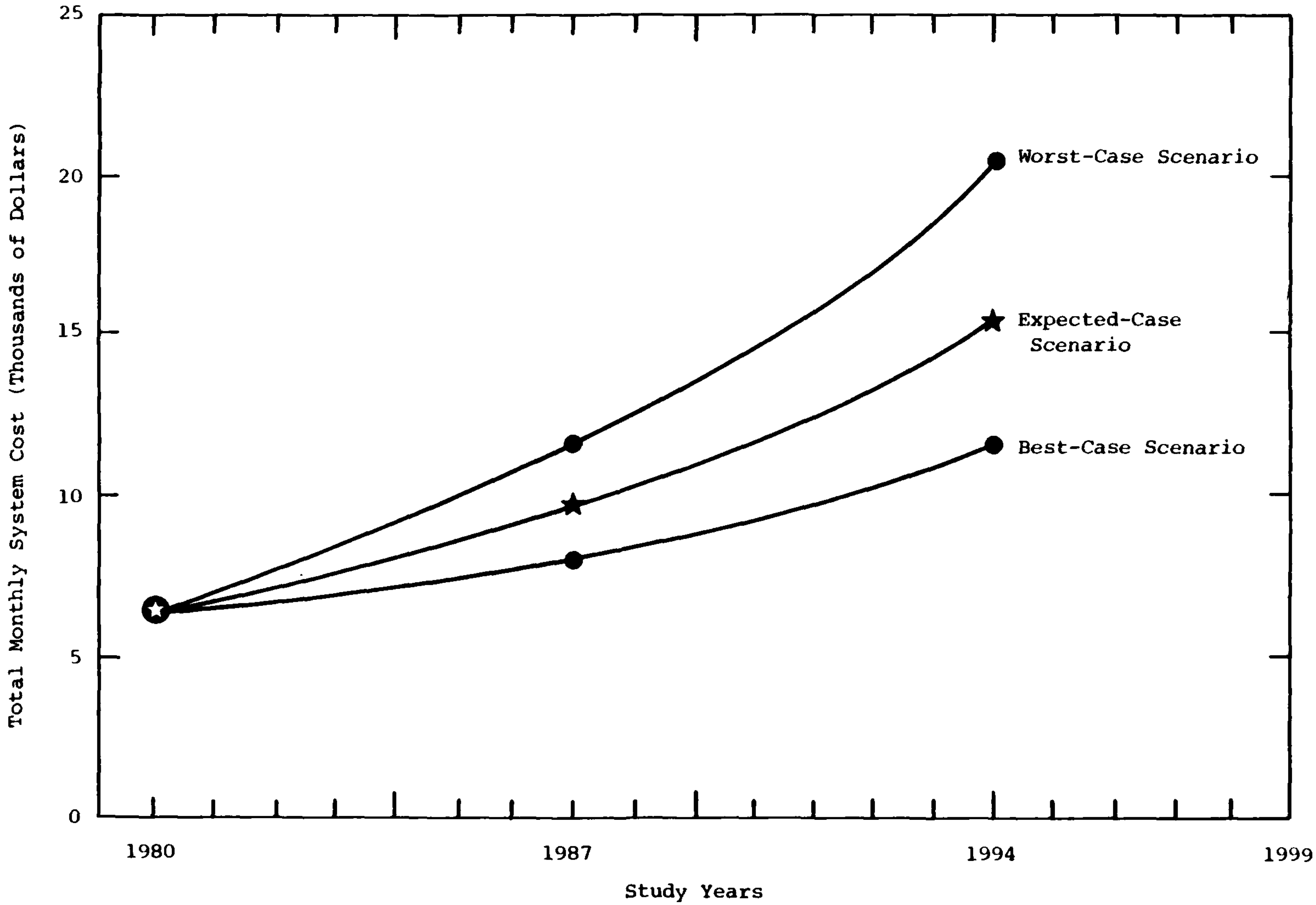

Figure 6-16. COST TRENDS FOR LEASED TANDEM SWITCHING EQUIPMENT

Table 6-59. SHORT AND LONG-TERM INFLATION FACTORS FOR LEASED TANDEM SWITCHING

Scenario	1987 Factor	1994 Factor	Short-Term (1987) Compound Inflation Rate (Percent)
Worst Case	1.667	2.875	7.6
Best Case	1.279	1.699	3.6
Expected Case	1.462	2.216	5.6

It is expected that the carrier will be better qualified to operate the satellite service and perform quality assurance and technical control functions associated with large-scale circuit cross-sections. The question of the economic viability of leasing substantial transponder and earth-terminal resources is not addressed in this study. Such technical considerations will have to be addressed by DCA and will require an extensive analysis of the DCS circuit data base to determine the circuit requirements matrix. Architectural studies must then be performed in which major alternatives are exhaustively studied in terms of technical attributes and economic performance. The user-acceptance problem associated with the space-link transmission delay may be minimal at the onset of service but may eventually become a major obstacle for several types of applications (i.e., certain data circuit requirements and high-priority circuit use), and the associated large-scale termination penalty or investment commitments might offer too great an economic risk.

The earth terminals examined in our cost trend study had antennas ranging in size from 10 to 11 meters, with low-noise front-ends, redundant principal subsystems, channel derivation, and nominal baseband size of at least 1.2 MHz. Vendors surveyed were Harris, Hughes, California Microwave, Farinon, and ComTech Labs. We noted that the pricing of earth terminal facilities is in a state of flux and that makers are building terminals to order. We could learn little about terminal price trends, and we think that a major procurement would be warranted (versus piecemeal procurement) in order to obtain substantial control of the acquisition cost. It is expected that a fully equipped and installed backbone-route earth terminal will cost approximately $1.2 million. The CTC-PAM was used to project costs, given the worst-case, best-case, and expected-case inflation scenarios presented in Table 6-60.

Table 6-61 depicts the associated short-term and long-term inflation factors associated with the leased earth terminal. The monthly costs are expected to be $60,150 and $91,050 in 1987 and 1994, respectively. The expected short-term compound inflation rate is 3.6 percent, which translates to a monthly increase of approximately $1,500.

Table 6-60. INFLATION RATES ASSOCIATED WITH LEASED EARTH TERMINAL FACILITIES

Scenario	Equipment Cost Inflation (Percent)	Operating Cost Inflation (Percent)
Worst Case	4	12
Best Case	0	8
Expected Case	2	10

Table 6-61. SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR LEASED EARTH TERMINAL FACILITIES

Scenario	1987 Factor	1994 Factor	Short-Term Compound Inflation Rate (Percent)
Worst Case	1.67	2.10	7.6
Best Case	1.27	1.70	3.6
Expected Case	1.46	2.21	5.6

CHAPTER SEVEN

SUMMARY OF FINDINGS AND CONCLUSIONS

This chapter summarizes the significant findings and conclusions developed in our investigation of trends in CONUS common carrier offerings. Also included are discussions of possible emerging services, beneficial effects of competition, and issues surrounding DCA's procurement of CONUS common carrier services. The chapter concludes with a discussion of the benefits of the study of cost trends in common carrier offerings and identifies areas requiring further study.

7.1 TRENDS OF PRESENT SERVICES

On the basis of the analysis results presented in Chapter Six, the short-term and long-term trends of representative service categories for each of the carriers studied are summarized in Table 7-1. This table gives the expected short-term (1987) and long-term inflation factors and short-term (1987) compound inflation rate for services by carrier. Scenario inflation factors, other relevant factors (e.g., FCC dockets and court rulings), and specific tariff rates and structures were summarized in the preceding chapters. This section summarizes the trends shown in Table 7-1 in terms of two categories: highly volatile services and stable services.

7.1.1 Highly Volatile Services

The criteria we have selected for the highly volatile category are the following: (1) the service is under heavy attack by the FCC, (2) it has a compound short-term inflation rate greater than 6 percent, (3) it is slowly being phased out by the carrier or by regulatory and economic factors, and (4) it is expected to be restructured. Services in this category that include some or all of the criteria are listed in Table 7-2. All other services are considered relatively stable.

AT&T's MPL and Telpak are considered volatile, since both have been ruled unlawful by the FCC. MPL is expected to be restructured under the pending FCC proceedings, and Telpak is expected to be replaced by a new tariff offering that will provide specialized discounts to large-volume users. We expect these discounts to reflect wholesale costs of service. It is also inevitable that AT&T will have to offer a less expensive, shared-use, measured-time or message-unit, point-to-point private-line

Table 7-1. SUMMARY OF SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR SERVICES STUDIED

Service	1987 Inflation Factor	1994 Inflation Factor	Compound Short-Term (1987) Inflation Rate (Percentage)
AT&T			
• MPL	1.113	1.25	1.5
• Telpak	1.086	1.483*	1.2*
• DDS			
•• 1.544 Mbps	1.73	2.96	8.1
•• 4.8 Kbps	1.732	2.979	8.2
• Local Distribution			
•• With Switching Access	1.700	2.800	7.9
•• Without Switching Access	1.634	2.757	7.3
• WATS	1.27	2.72	3.5
• CCSA	2.705	*	*
• EPSCS	1.40	3.01	5.0
MCI			
• Private-Line Service	1.40	2.1	4.9
• CCSA	1.57	2.91	6.8
• EXECUNET	1.40	2.0	4.9
SPCC			
• Private-Line Service	1.4	2.1	4.9
• SPRINT	1.42	2.1	5.0
WU Satellite Service	1.3	1.5	2.4
RCA Satellite Service	1.18	1.46	3.1
Terminal Devices			
• PBX under 500 Lines (Class 5)	1.46	2.219	5.6
• Over 500 Lines (Class 4/5)	1.452	2.191	5.5
• Tandem Switch	1.462	2.216	5.6
• Earth Terminal	1.46	2.21	5.6

*Service not expected to be offered.

Table 7-2. SERVICES CONSIDERED HIGHLY VOLATILE

Service	Reasons				Remarks
	1	2	3	4	
MPL	X	O	X	X	• Restructuring is expected under FCC proceedings. • Pricing is anticompetitive.
Telpak	X	O	X	O	• It will be withdrawn by AT&T concurrently with MPL restructuring. • Service has been under heavy attack for some time.
DDS	X	X	O	O	• It is under FCC attack because of anticompetitive rates.
CCSA (AT&T)	O	X	X	O	• Service has been made obsolete by introduction of EPSCS. • Rates are expected to increase significantly because investments cannot be reused.
Local Distribution (AT&T)	O	X	O	O	• Rates have been a primary economic hurdle to interconnection to OCC's service.

O - Reason does not apply.
X - Reason applies.

Reasons:

1. Service is under heavy attack by FCC.
2. Service has a compound short-term inflation rate greater than 6 percent.
3. Service is slowly being phased out by carrier, FCC, and economic factors.
4. Service is expected to be restructured.

offering for the smaller users of private lines. Another aspect of the AT&T private-line services is that we found the cost studies to be very heavily leveraged by separations methodologies, which could cause increases in private-line investments and operating expenses.

AT&T's DDS, CCSA, and local distribution are all considered to be volatile because of an excessive compound short-term (1987) inflation rate. DDS is a highly competitive service that has been under attack since its initiation. We expect this service to be contested heavily from the standpoint of anticompetitive pricing over the next 15 years, so that the service will be relatively inflationary. The service requires considerable maintenance and testing because most data systems have a high level of quality control and a higher circuit reliability requirement than the customary analog channels. As a result the carrier will spend more maintenance dollars than normal, and the service will become more inflationary. CCSA is now outdated, since it is primarily based on older crossbar switching technology. Compared with the EPSCS service (the service replacing CCSA), CCSA is not attractive. The introduction of EPSCS has caused a migration of large CCSA customers to EPSCS and the abandonment of now useless switching equipment. As this migration accelerates, the level of CCSA pricing will have to be increased heavily because of the amortization of large CCSA investment costs. It is expected that this avalanche-like phenomenon will cause the service to become extremely overpriced by 1985 and to be completely withdrawn by 1987. Thus, the CCSA and the switched automatic network (SCAN) tariff offering (which provides the leased AUTOVON switching nodes) is almost certainly doomed to be withdrawn by 1987. The DoD must explore alternative methods of procuring its switching systems and must make plans that will exploit the advantages of newer digital switching technology and enhance competition by precluding a single-vendor acquisition approach.

AT&T's local distribution is expected to increase in cost by 7.3 percent to 7.9 percent (short-term compound inflation rate) over the next seven years. It is expected that no significant changes in technology and maintenance will be placed into service, which may slow the increase in cost of local distribution. Many large corporations in cities of high circuit density will probably start setting up their own local distribution facilities (e.g., rooftop satellite terminals) in order to obtain a more stabilized and less expensive local distribution.

7.1.2 Stable Services

The services offered by MCI, SPCC, Western Union, RCA, and AT&T's WATS and EPSCS are expected to have short-term inflation rates of less than 6 percent per year. The most stable services are the RCA and Western Union satellite services, which are expected to have compound short-term inflation rates of 3.1 and 2.4 percent, respectively. These low figures are due to the relatively fixed transponder costs of the space link and the relatively low cost of the more inflationary earth terminals. We consider satellite services to be the most economic services where the attendant delays are not a problem. WATS is considered exceptionally stable; however, the FCC has been looking at WATS in relation to the MTS, and there is concern about the structure of WATS in the short term and long term. We expect that the FCC will allow a bulk-purchase service that is area-related (as opposed to point-to-point) in terms of stations that may be accessed and that the rates for the service will be about as stable as the present WATS rates.

We think that MCI and SPCC will experience significant growth and that their services will exhibit modest rates of inflation, because the SCCs employ all-new technology and are not "rate-base-justified"* but rather are commercial services that are as successful as their sales, use of capital, and productivity. We noted that MCI (as of February 1980) generates $118,000 in annual revenue per employee and that AT&T generates approximately $50,000 in annual revenue per employee. This contrast indicates that MCI is using new technology and achieving high productivity. It is also expected that the OCCs will utilize their facilities to a greater extent, because they will need to maximize their sales for any level of plant investment. A brief review of the SCCs' tariff structures will verify the use of night and weekend rates that are substantially lower than business day rates. This practice is designed to obtain a higher degree of facility utilization and greater revenue generation per unit of investment.

7.2 POSSIBLE EMERGING SERVICES

Our studies have shown that all the intercity services are, or will be, highly cross-elastic and interchangeable with AT&T's present MTS and its bulk equivalent, WATS services. The distinction between MTS and private line is arbitrarily drawn by price. That is, if MTS were cheaper than private line, given the average business's traffic patterns, there would be no need for private-line service. We believe that there is a continuum of possible services based on price and function. We expect that AT&T's private-line services will be restructured in terms of price but that no new emerging service will evolve. PBXs, tandem switches, and Class 4/5 switches will probably be offered by carriers for interstate use in a tariff format because there is a substantial market for this type of service given the economies of decentralized or distributed switching arrangements, where much of the network intelligence resides in the carrier's backbone network. We expect that more data processing, electronic data interchange, word processing, and other information-related processing functions will appear as a part of service offerings in combination with classical voice and data transmission and switching.

7.3 BENEFICIAL EFFECTS OF COMPETITION

We think that one of the major effects of competition has been to stimulate the telecommunications marketplace with the infusion of new technology, services, prices, and marketing endeavors. In effect, we are saying that the marketplace is now experiencing the beneficial effects of American free enterprise. We indicated earlier our belief that a continuous spectrum of services is possible. It is through creative and innovative competition that the gaps in this spectrum will be filled and customers will receive services and technology that they would not have received otherwise. We think too that free competition will provide the best kind

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*That is, they are compensated not according to the size of their rate base but according to their sales.

of regulation. If an independent carrier is able to offer a service at a lower price than a monopoly and if that carrier remains viable and financially stable, the marketplace has rejected the argument for monopoly. Thus, the FCC's decisions to allow competition have been a long step toward allowing the telecommunications marketplace to enjoy new technology and new ideas and generally to benefit from a broader spectrum of services and pricing.

7.4 PROCUREMENT OF CONUS COMMON CARRIER SERVICES

Our studies have shown that changes are to be expected in economic, regulatory, judicial, and technology factors that can be extremely costly to the DCS. We have pointed out that economically stable alternative services exist and that competitive forces are beneficial. We think that in planning the procurement of CONUS common carrier services DCA should study the DCS to determine what services are able to apply a cost benefit, what the savings are, what kind of an organization is able to support a multivendor procurement environment, what services apply, and what the vulnerability considerations of the translated network are. Our study has shown that circuits may be procured at incremental mileage rates of $0.40 per mile from satellite carriers and $0.44 to $0.50 per mile from SCCs. The existing tariffs and service coverage of cities by no means exhaust the realm of transmission possibilities. For instance, it is conceivable that the DCS could lease radio channels for its major backbone city pairs and provide its own end-terminal and intermediate terminal multiplexing. The leasing of microwave routes would be subject to interstate tariff, but the multiplexer equipment would not, since the equipment would be provided by the customer. In this plan the carrier would be responsible for maintenance of the microwave transmission system, and the customer (or his contractors) would be responsible for the multiplexer maintenance. The benefits of this type of plan are as follows:

- The customer pays only for the multiplexing and transmission he maintains.
- The transmission system could be designed to support 1.544 Mbps to aid in economically interconnecting a digital tandem switched network and various types of data systems.
- The customer is able to reduce or limit the amount of tariffed services subject to rate increases.
- A specialized system would be useful to provide quality control for a multicarrier and specialized transmission system lease.

This type of procurement is active and requires extensive coordination and planning, including the following:

- Establish and maintain a complete and accurate automated data base of tariff rates and short-term and long-term trend projections.
- Establish and maintain a specialized data base of NCS circuit requirements, which may easily be processed by a computerized network architecture type of program.

- Develop computer programs that will build alternative networks from the specialized circuit data base and allow the network costs to be determined in the following terms:
  - Baseline cost for present vendor system
  - Least-cost multivendor network
  - Least cost by number of selected vendors

All of these projections should include a short-term and long-term economic trend of the total network cost, given various factor scenarios, in order to determine the most economically stable vendor configuration.

7.5 BENEFITS OF THE STUDY AND AREAS REQUIRING FURTHER STUDY

The major benefits of this study include the following:

- The development of an extensive data base of interstate carrier service costs that can be directly used to project cost of service for major tariff offerings
- The development of the CTC-PAM model, which is capable of providing trend analysis of interstate services, given postulated inflation and technology scenarios
- The establishment of initial short-term and long-term projections of inflation factors for major interstate service offerings
- The recognition of the rapidly growing financial and operating strength of the other common carriers
- The recognition and examination of highly volatile interstate services
- A statement of the possible rates and trends of a restructured AT&T private-line service

We expect that the DCA will require continued analysis of cost trends for existing and emerging services to test their economic viability as candidate tariffs for the DCS network. The CTC-PAM model and data base will provide the tools for this type of investigation. Additional work in the following areas can provide a more complete assembly of tools:

- To build an interface for the CTC-PAM to allow the model to deliver time-variant rates to a multivendor pricing program
- To analyze carrier cost trends, update unit costs, add new services, and refine the CTC-PAM's uses
- To construct pragmatic transmission and switching system approaches to the advanced phases of the DCS and test the resultant economic stability under various procurement approaches
- To integrate the use of the CTC-PAM into the normal planning function of the DCS to ensure that refinements are appropriate to DCS needs

7.6 A SUMMARY OF SIGNIFICANT FINDINGS AND CONCLUSIONS

We found that an AT&T-based transmission and switching system, while it may appear to be relatively stable at present, will be subject to tremendous upward pressure in pricing because of economic, regulatory, and judicial factors. It is expected that major restructuring of interstate services will force large users to take a serious look at an integrated multivendor environment. Since AT&T is the price leader in the carrier business, it is expected that OCCs will price in relationship to AT&T and provide a degree of discount that will balance facility lease with profits. For this reason, the encouragement of competition in the interstate marketplace will be beneficial in keeping prices of offered services in line.

We expect that most interstate services will experience significant growth and that diversification will provide new services and economic savings.

We have found that the interstate transmission facilities and tariffs are virtually tied up in regulatory proceedings and that their rates will tend to be economically unstable. In this area of service, it is expected that the IBM/AETNA partnership (Satellite Business System) and Xerox (XTEN) type of services may aid in defining price and the structure of the marketplace. Since these services are young (e.g., DDS) or still in the planning stage, we expect that a commitment to an advanced digital voice and data network would be expensive and risky. At best, transition from a present carrier-based transmission and tandem switching network should be evolutionary and use "safe" technologies. Such technologies would allow the newer concepts in trunking, maintenance, technical control, and switching to be easily accommodated.

APPENDIX A

OVERVIEW OF THE CTC-PAM MODEL

1. INTRODUCTION

The Commercial Telecommunications Cost Prediction and Analysis Model (CTC-PAM) consists of a main program and 23 subroutines functionally organized in the following 6 areas:

- Control
- User interface
- Data input
- Telecommunications service control
- Cost calculation
- Output

The primary means by which the subroutines are controlled and through which the subroutines receive necessary data is the FORTRAN named COMMON block. For convenience and ease of identification of variables, 17 named COMMON blocks are used. Also, the argument list is used to pass data to the subroutines in order to save instructions and preserve the generality of the subroutines' design functions.

The relationships of the 6 functional groups of the model are shown in Figure A-1.

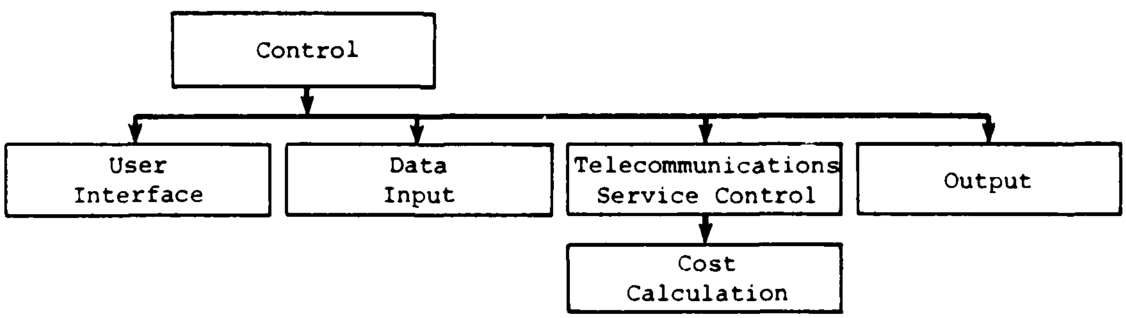

Figure A-1. RELATIONSHIPS OF 6 FUNCTIONAL GROUPS

The purpose of each functional group is as follows:

- Control. On the basis of user requests, this ensures that the appropriate subroutines are called to initialize all variables and perform the appropriate service prediction calculations.
- User Interface. This solicits user input appropriate to the service for which cost prediction is requested. This module contains requests for data for all telecommunications services contained in the model. The control module determines which parts of this module are exercised.
- Data Input. This module (consisting of 2 FORTRAN subroutines) loads the CTC-PAM data base into the named COMMON blocks and performs initialization of certain data elements.
- Telecommunications Service Control. This module contains 14 FORTRAN subroutines, all having similar functions. According to the service selected for cost prediction, one of the service subroutines is called. These routines ensure that the building block algorithms for the predicted service are properly assembled and that costs for each block are calculated.
- Cost Calculation. This module consists of 5 subroutines that perform the cost calculations, using cost vectors and other parameters passed from the telecommunications service control subroutines.
- Output. This module consists of a single subroutine, which, under control of the main program, displays cost calculation results in one of two user-selected levels of detail.

2. SUBROUTINE IDENTIFICATION

Subroutines contained in each functional group and their functions are presented in the following sections.

2.1 Control Functions - TELCOM

TELCOM is the main program. It solicits user input of run-level information such as prediction year, number of iterations of the model, model termination requests, and similar information. This program also controls the invoking of all user interface, data input, telecommunications service control, and output subroutines.

2.2 User Interface Function - INSPEC

The INSPEC subroutine solicits user input of service specifications, such as number of terminals, class of service, and number of trunks. The particular information solicited is dependent on the service selected and is controlled by TELCOM.

2.3 Data Input Function

Subroutines for the data input function are as follows:

- READIN. This subroutine loads the data base into named COMMON blocks and performs some initial calculations to prepare the data for further use by the cost calculation functional group.
- TAXPHI. This subroutine initializes the federal income tax/rate-of-return factors for use by the cost calculation group.

2.4 Telecommunications Service Control Function

Subroutines for the telecommunications service control function are as follows:

- EXCHNG. Controls cost calculations for exchange service.
- MESSAG. Controls cost calculations for message service.
- WATS. Controls cost calculations for inward and outward WATS service.
- PLASBV. Controls cost calculations for private-line (analog) subvoice service.
- PLAVFX. Controls cost calculations for private-line (analog) voice and private-line (analog) foreign exchange services.
- PLADAT. Controls cost calculations for private-line (analog) data service.
- PLDIGT. Controls cost calculations for private-line digital service.
- PLBULK. Controls cost calculations for bulk private-line service.
- WIDEBD. Controls cost calculations for wideband service.
- NODESW. Controls cost calculations for two types of node switching service, one for fewer than 500 lines and trunks and the other for 500 to 1,000 lines and trunks.
- MCIPPL. Controls cost calculations for MCI point-to-point private-line (analog) service.
- SPCCPL. Controls cost calculations for SPCC point-to-point private-line (analog) service.
- ENFIA. Controls cost calculations for ENFIA service.
- SATCOM. Controls cost calculations for Western Union satellite service.

2.5 Cost Calculation Function

Subroutines for the cost calculation function are as follows:

- COSTA. Calculates intermediate and object costs for a single cost vector. It also applies to the calculation of a technology density factor, a route-band factor, mileage, time, and number of units of equipment. It also applies user-input changes to the data base inflation rates.
- COSTI. Calculates intermediate and object costs by interpolating between two discrete, mileage-related cost vectors. It applies to the cost calculations of a technology density factor, time, units of equipment, and user-input changes to the data base inflation rates.
- COSTP. Calculates intermediate and object costs exactly as COSTA does, except that it calculates no embedded capital costs. It is used for services that have only current costs.
- MILEAG. Calculates the interpolation factor used in COSTI from a table of discrete mileage ranges and the user-input mileage for the service.
- BANDNO. Given a mileage and a table of air-band mileage ranges, this subroutine computes the air-band number that the service control program uses to control cost calculations dependent on air- and route-band density functions.

2.6 Output Function - PRINTC

- This subroutine prints the computed costs in any of two available output formats. The output format is user-specified and controlled by the main program.

3. DESCRIPTION OF SUBROUTINES

Each subroutine (and main program) will be described in the following format:

- Overview of logic
- Variables
- Equations (where appropriate)

Discussion of the named COMMON blocks that contain the data base is presented under the READIN subroutine (Section 3.3).

3.1 TELCOM (Main Program)

3.1.1 Overview of Logic

The main program first causes the data base to be loaded by calling the subroutine READIN. It then displays the menu of services and solicits from the user the service to be analyzed. After initializing service dimension and cost variables to zero, the user is asked to input the following prediction dimensions:

- Prediction year, number of iterations, and delta year. The prediction year may be any year from 1980 to 1994. The model will produce one cost prediction for each iteration. Second and subsequent iterations add one value of delta year to the year predicted in the previous iteration.
- Delta inflation. The user may input up to 5 (including none) sets of inflation deltas for facilities, labor, and maintenance and repair (M&R) inflation rates. After producing one cost prediction for each year using zero delta inflations, the model will produce additional predictions for each year, depending on the number of delta inflation sets inputted by the user.
- Federal income tax/rate-of-return (FIT/ROR) scenario. The user may cause the model to produce cost predictions for one FIT/ROR scenario in addition to the baseline scenario. The user may input a constant FIT/ROR factor or may input the start-up values, baseline inflation, and inflation rate of change used to compute FIT/ROR factors.
- Type of output. The user may select detailed cost subtotals or summary cost subtotals. See PRINTC subroutine.

Depending on the service selected, the appropriate cost control subroutine is called to generate the component cost values. When control is returned to TELCOM, the cost totals are produced and printed output is produced by calling PRINTC subroutine to print the cost prediction. Finally, the cost answer arrays are zeroed in preparation for another prediction. These three steps are accomplished once for each combination of prediction year, delta-inflation scenario, and FIT/ROR scenario. The first iteration uses the data base FIT/ROR scenario, and the second loop, if required, uses the user-input FIT/ROR scenario.

3.1.2 Variables

Key variables used in the main program are as follows:

Name	Description
PREVSC	Saves pointer to last service for which cost prediction was made. This is necessary because two different FIT/ROR baseline scenarios are in the data base -- one for

Name	Description
	SPCC and one for all other services. Using this variable, TELCOM controls the generator of FIT/ROR factors in the TAXPHI subroutine.
SERVICE (2,18)	Contains names of the services for presentation to the user. The user enters the integer representing the service to be costed. The following services* are available:

1-EXCHANGE	10-PRIVATE LINE -- BULK
2-MESSAGE	11-WIDEBAND
3-OUTWARD WATS	12-NODE SWITCH: <500
4-INWARD WATS	13-NODE SWITCH: >500
5-PRIVATE LINE -- SUBVOICE	14-MCI POINT-TO-POINT
6-PRIVATE LINE -- VOICE	15-SPCC POINT-TO-POINT
7-PRIVATE LINE -- FX	16-ENFIA (SWG-OCC)
8-PRIVATE LINE -- DATA	17-SATELLITE (WU)
9-PRIVATE LINE -- DIGITAL	18-STOP RUN

IYR	Prediction year
NI	Number of iterations on year
DY	Delta-year
DL	Number of delta-inflation scenarios. Must be an integer, 1 through 6.
DI(3,6)	Delta-inflation factors. Contains baseline delta-inflation factors of zero for facilities, labor, and M&R and up to 5 sets of user-inputted delta-inflation factor.
ROR	Integer variable used first to record user's desire to enter a FIT/ROR scenario and, second, to record type of scenario (constant or inflating).
TAXC(I,3)	Used to record user-input FIT/ROR scenario
NTAXV	Controls iterations on tax scenario. Has one of only two values (1 or 2).
C	Value "Y" for detailed cost subtotals Value "N" for summary cost subtotals See PRINTC subroutine.
YR	Integer value used as index to data that are dependent on year. For 1980, YR=1; 1981, YR=2; etc.
D(3)	Contains transformed delta-inflation factors for each iteration or inflation. D(I) = DI(I) + 1.0

*Refer to Table A-1 for identification of carriers and a description of servicer input options. All tables are at the end of this appendix.

Name	Description
INCTRL(14,17)	Each of the 17 services (the 18th is "STOP RUN") requires different service dimensions from the user. This array contains pointers to 14 different questions in subroutine INSPEC. A non-zero entry in INCTRL indicates that the corresponding question (1 to 14) is an input requirement for the service to be predicted.

3.2 TAXPHI

3.2.1 Overview of Logic

This subroutine computes a FIT/ROR factor for each prediction year 1980 through 1994. Using input variables and data base variables it produces the 15 factors with a DO loop.

3.2.2 Variables

Key variables used in the TAXPHI subroutine are as follows:

Name	Description
I	Passed from calling routine, used to index tax scenario data (start-up values, inflation, and inflation rate of change) in arrays TAXC and TAXV. If I = 1, baseline tax data for all services except SPCC are used. If I = 2, baseline tax data for SPCC service are used. If I = 3 or 4, user input tax data are used. If I = 1 or 3, tax variables in the data base for other than SPCC are used. If I = 2 or 4, tax variables in the data base for SPCC are used.
J	Passed from calling routine. Used to index array PHI (the tax factors). If J = 1, baseline PHI is computed. If J = 2, user PHI is computed
TAXC(4,3)	Contains 3 sets of 4 tax constants. Each set contains debt-interest start-up value, return-on-equity start-up value, inflation rate and inflation rate-of-change. The 3 sets are (1) baseline for non-SPCC services, (2) baseline for SPCC service, and (3) user input.
TAXV(15,4,2)	Contains 15 yearly values for 4 variables: (1) debt ratio, (2) debt interest, (3) return-on-equity, and (4) effective tax rate. One set of the above is for (1) non-SPCC services and (2) SPCC services.

Name	Description
PHI(15,2)	Contains FIT/ROR factor for each of 15 years. The first set (1) is for non-SPCC services, the second set (2) for SPCC services.

3.2.3 Equations

$\Phi(t)$ = FIT/ROR for year t

D_r = debt ratio

I = debt interest

ETR = effective tax rate

ROE = return on equity

I_o = inflation rate

$\frac{dI}{dt}$ = rate of change of inflation

n = year (1 to 15)

γ_1 = I start-up value

γ_2 = ROE start-up value

$$\Phi(t) = D_r \left[I + \gamma_1 \; [1 + a]^n - \gamma_1\right] + \frac{1 - D_r}{1 - ETR} \left[ROE + \gamma_2 \; [1 + a]^n - \gamma_2\right]$$

where

$$a = \left(\frac{15}{I_o} \times \frac{dI}{dt}\right)^{\frac{1}{15}} - 1$$

3.3 READIN

3.3.1 Overview of Logic

This subroutine reads data identifiers in the data base and, according to the location of the identifier in an array, branches to the appropriate formatted read statement to load the data into an array. This process continues until a terminating identifier (zzzzzz) is read. The data base is now loaded, and 3 steps in data initialization are accomplished, as follows:

- Line-haul, end terminal multiplexing, and intermediate terminal multiplexing route-band densities are multiplied by the appropriate air- to route-band conversion factor. This is accomplished here to save multiplication steps in the cost subroutines.

Unit testing expense values, read in independently, are moved to the appropriate places in the arrays containing voice and data private line cost vectors for line-haul, end terminal multiplexing, and intermediate terminal multiplexing data.

Data for Schedules II and III for voice and data private-line line-haul, end terminal, and intermediate terminal multiplexing are set equal to corresponding data for Schedule I, because Schedule I cost data are currently treated as Schedules II and III data.

3.3.2 Variables

Each data base array contains one or more cost vectors, depending on the type of data. Each cost vector contains 13 data elements (see COSTA), represented below by I = 1,13. The data base array listing follows:

Keyword	Description	Variable Name & Array Structure
BTE	- Basic Telephone	BTKT(I,1) I = 1,13
KTE	- Key Telephone	BTKT(I,2) I = 1,13
MTE	- Modem	MTE(I) I = 1,13
TWRE	- Terminal Wire Residence	TWRB(I,1) I = 1,13
TWBE	- Terminal Wire Business	TWRB(I,2) I = 1,13
TWIW	- Terminal Wire INWATS	TWIW(I) I = 1,13
BTM	- Basic Telephone per Message	BTKTM(I,1) I = 1,13
KTM	- Key Telephone per Message	BTKTM(I,2) I = 1,13
TWRM	- Terminal Wire Residence/Message	TWRBM(I,1) I = 1,13
TWBM	- Terminal Wire Business/Message	TWRBM(I,2) I = 1,13
MTEY	- CE, NB_C, NB_E for 15 Years for BTM, KTM, TWRM, TWBM Cost Vectors	MTEY(I,J) I = 1,15 years J = 1 CE J = 2 NB_C J = 3 NB_E
ALRE	- Access Line Residence	ALRB(I,J,K) I = 1,13
ALRB	- Access Line Business	J = 1 (4 technology densities) K = 1 (Residence) K = 2 (Business)

Keyword	Description	Variable Name & Array Structure
ALVE	- Access Line Voice	ALVEM(I,J) I = 1,13
ALVM	- Access Line Voice Message	J = 1 ALVE
		J = 2 ALVM
ALDE	- Access Line Data	ALDE(I) I = 1,13
ALVP	- Access Line, Private Line Voice	ALVP(I) I = 1,13
ALRM	- Access Line Residence per Message	ALRBM(I,J) I = 1,13
ALBM	- Access Line Business per Message	J = 1 ALRM
		J = 2 ALBM
AL48	- Access Line 48 KHz	AL48V(I,J) I = 1,13
ALVD	- Access Line Video	J = 1 AL48
		J = 2 ALVD
ALOW	- Access Line OUTWATS	ALOIW(I,J,K) I = 1,13
ALIW	- Access Line INWATS	J = 1,4 (4 technologies)
		K = 1 ALOW
		K = 2 ALIW
LAD	- Local Access Digital	LAD(I,J) I = 1,13
		J = 1 2.4 Kbps
		J = 2 4.8 Kbps
		J = 3 9.6 Kbps
		J = 4 56 Kbps
		J = 5 1.5 Mbps
ALPL	- Access Line Private Line	ALPL(I,J) I = 1,13
		J = 1,3 (3 technologies)
ALSV	- Access Line Subvoice	ALSV(I,J,K) I = 1,13
		J = 1,3 (3 technologies)
		K = 1 30 Baud
		K = 2 150 Baud

Keyword	Description	Variable Name & Array Structure
LAA4	- Local Access Technology Density	LAA4(I,J) I = 1,15 (15 years)
		J = 1,4 (4 technologies)
LAA3	- Local Access Technology Density	LAA3(I,J) I = 1,15 (15 years)
		J = 1,3 (3 technologies)
ETRE	- Exchange Trunk Residence	ETRB (I,J,K) I = 1,13
ETRB	- Exchange Trunk Business	J = 1,3 (3 technologies)
		K = 1 ETRE
		K = 2 ETRB
ETRM	- Exchange Trunk Residence per Message	ETRBM(I,J,K) I = 1,13
		J = 1,3 (3 technologies)
ETBM	- Exchange Trunk Business per Message	K = 1 ETRM
		K = 2 ETBM
ET48	- Exchange Trunk 48 KHz	ET48V(I,J) I = 1,13
ETVD	- Exchange Trunk Video	J = 1 ET48
		J = 2 ETVD
ETOW	- Exchange Trunk OUTWATS	ETOIW(I,J) I = 1,13
ETIW	- Exchange Trunk INWATS	J = 1 ETOW
		J = 2 RTIW
ETD	- Exchange Trunk Digital	ETD(I,J) I = 1,13
		J = 1 2.4 Kbps
		J = 2 4.8 Kbps
		J = 3 9.6 Kbps
		J = 4 56 Kbps
		J = 5 1.5 Mbps
ETPL	- Exchange Trunk Private Line	ETPL(I) I - 1,13
ETSV	- Exchange Trunk Subvoice	ETSV(I,J) I = 1,13
		J = 1 30 Baud
		J = 2 150 Baud
ETA3	- Exchange Trunk Technology Densities	ETA3(I,J)
		I = 1,15 (15 years)
		J = 1,3 (3 technologies)

Keyword	Description	Variable Name & Array Structure
LSRE	- Local Switching Residence	LSRB(I,J,K) I = 1,13
LSBE	- Local Switching Business	J = 1,3 (3 technologies) K = 1 LSRE K = 2 LSBE
LSMD	- Local Switching per Message Direct Distance Dialing	LSMDO(I,J,K) I = 1,13 J = 1,3 (3 technologies)
LSMO	- Local Switching per Message Operator-Assisted	K = 1 LSMD K = 2 LSMO
LSOW	- Local Switching OUTWATS	LSOIW(I,J,K) I = 1,13
LSIW	- Local Switching INWATS	J = 1,3 (3 technologies) K = 1 LSOW K = 2 LSIW
LSA3	- Local Switching Technology Densities	LSA3(I,J) I = 1,15 (15 years) J = 1,3 (3 technologies)
TSOW	- Toll Switching OUTWATS	TSOIW(I,J,K) I = 1,13
TSIW	- Toll Switching INWATS	J = 1 up to 50 miles J = 2 50 - 3,000 miles K = 1,2 TSOW technologies 1 and 2 K = 3,4 TSIW technologies 1 and 2
TSM	- Toll Switching per Message	TSM(I,J,K) I = 1,13 J = 1 up to 50 miles J = 2 51 - 3,000 miles K = 1,2 Fixed and mileage dependent costs, technology 1 K = 3,4 Fixed and mileage dependent costs, technology 2
TSMDST	- Upper Mileage for Toll Switching Mileage Intervals	TSMDST(I) I = 1 50 miles I = 2 3,000 miles

Keyword	Description	Variable Name & Array Structure
TSA2	- Toll Switching Technology Densities	TSA2(I,J) I = 1,15 (15 years) J = 1,2 (2 technologies)
LHD	- Intercity Line-Haul Digital	LHD(I,J,K) I = 1,13 J = 1 up to 76 miles J = 2 77 to 163 miles J = 3 164 to 250 miles J = 4 251 to 375 miles J = 5 376 to 500 miles J = 6 501 to 750 miles J = 7 751 to 1,000 miles J = 8 1,001 to 3,000 miles K = 1 2.4 Kbps K = 2 4.8 Kbps K = 3 9.6 Kbps K = 4 56 Kbps K = 5 1.5 Mpbs
LH48	- Intercity Line Haul 48 KHz	LH48V(I,J,K) I = 1,13
LHVD	- Intercity Line Haul Video	For LH48 (K = 1) J = 1 up to 76 miles J = 2 77 to 3,000 miles For LHVD (K = 2) J = 1 up to 50 miles J = 2 51 to 3,000 miles
LHDL	- Intercity Line Haul Data	LHDL(I,J,K) I = 1,13 J = 1,10 for 10 route bands K = 1,2 Technology 1 and 2 Schedule I K = 3,4 Technology 1 and 2 Schedule II K = 5,6 Technology 1 and 2 Schedule III

Keyword	Description	Variable Name & Array Structure
LHSV	- Intercity Line Haul Subvoice	LHSV(I,J,K) I = 1,13 J = 1 up to 50 miles J = 2 51 to 175 miles J = 3 176 to 375 miles J = 4 376 to 750 miles J = 5 751 to 1,750 miles K = 1 30 baud K = 2 150 baud
LHPL	- Intercity Line Haul Private Line	LHPL(I,J,K) same as LHDL
LHTC	- Intercity Line Haul Bulk 60 Channels	LHTCD(I,J,K) I = 1,13 J = 1,10 route bands K = 1 60 channels K = 2 240 channels
LHTD	- Intercity Line Haul Bulk 240 Channels	
LHM	- Intercity Line Haul per Message	LHM(I,J,K) I = 1,13 J = 1,10 route bands K = 1,2 (2 technologies)
LHOW	- Intercity Line Haul OUTWATS	LHOIW(I,J,K) I = 1,13 J = 1,10 route bands K = 1,2 OUTWATS, 2 technologies K = 3,4 INWATS, 2 technologies
LHIW	- Intercity Line Haul INWATS	
LHBND	- Route Band Densities per Air Band	LHBND(I,J,K) I = 1,10 air bands J = 1,10 route bands K = 1,3 schedules I, II, III
LHA2	- Line Haul Technology Density	LHA2(I,J,K) I = 1,10 10 route bands J = 1,2 (2 technologies) K = 1,3 schedules I, II, III
ABFCT	- Air to route miles conversion factors	ABFCT(I,J) I = 1,10 10 route bands J = 1,3 schedules I, II, III

Keyword	Description	Variable Name & Array Structure
LHDDST	- Mileage Intervals for Line Haul Variable LHD	LHDDST(I) I = 1,8 mileage intervals
LH48VD	- Mileage Interval for Line Haul Variables LH48, LHVD	LH48VD(I,J) For J = 1, I = 1,2 LH48 intervals For J = 2, I = 1,2 LHVD intervals
LHSVDS	- Mileage Interval for Line Haul Variable LHSV	LHSVDS(I) I = 1,5 5 mileage intervals
AIRDST	- Air Band Distance Table	AIRDST(I) I = 1,10 for 10 air band intervals with upper limits as follows 25, 50, 100, 150, 200, 250, 300, 500, 1,000, 3,000
EMPL	- End Terminal Multiplexing Voice	EMPL(I,J,K) same as LHPL
EMTC	- End Terminal Multiplexing Bulk 60 Channels	EMTCD(I,J,K) Same as LHTCD
EMTD	- End Terminal Multiplexing Bulk 240 Channels	
EMM	- End Terminal Multiplexing per Message	EMM(I,J,K) Same as LHM
EMOW	- End Terminal Multiplexing OUTWATS	EMOIW(I,J,K)
EMIW	- End Terminal Multiplexing INWATS	Same as LHOIW
EMD	- End Terminal Multiplexing Digital	EMD(I,J) Same as LHD
EMDL	- End Terminal Multiplexing Data	EMDL(I,J,K) Same as LHDL
EM48	- End Terminal Multiplexing 48 KHz	EM48V(I,J) I = 1,13
EMVD	- End Terminal Multiplexing Video	J = 1 48 KHz J = 2 Video
EMBND	- End Terminal Multiplexing Route Band Densities per Air Band	LHBND(I,J,K) Same as LHBND
EMA2	- End Terminal Multiplexing Technology Densities	EMA2(I,J,K) Same as LHA2
IMPL	- Intermediate Terminal Multiplexing Voice	IMPL(I,J,K) Same as LHPL
IMTC	- Intermediate Terminal Multiplexing Bulk 60 Channels	IMTCD(I,J,K) Same as LHTCD
IMTD	- Intermediate Terminal Multiplexing Bulk 240 Channels	
IMM	- Intermediate Terminal Multiplexing per Message	IMM(I,J,K) Same as LHM

Keyword		Description	Variable Name & Array Structure
IMOW	-	Intermediate Terminal Multiplexing OUTWATS	IMOIW(I,J,K) Same as LHOIW
IMIW	-	Intermediate Terminal Multiplexing INWATS	
ITD	-	Intermediate Terminal Multiplexing Digital	ITD(I,J,K) Same as LHD
IMDL	-	Intermediate Terminal Multiplexing Data	IMDL(I,J,K) Same as LHDL
IMPL	-	Intermediate Terminal Multiplexing Voice	IMPL(I,J,K) Same as LHPL
IMA2	-	Intermediate Terminal Multiplexing Technology Densities	IMA2(I,J,K) Same as LHA2
IMBND	-	Intermediate Terminal Multiplexing Route Band Densities per Air Band	IMBND(I,J,K) Same as LHBND
MCI	-	MCI Service	
		MCI Multiplexing	MMUX(I,J) I = 1,13 J = 1,2 (2 technologies)
		MCI Line Haul	MLHC(I,J) I = 1,13 J = 1,2 (2 technologies)
		MCI Technology Density	MCIA2(I,J) I = 1,15 15 years J = 1,2 two densities
SPCC	-	SPCC Service	
		SPCC Multiplexing	SMUX(I,J) I = 1,13 J = 1,2 (2 technologies)
		SPCC Circuits	SCKS(I,J) I = 1,13 J = 1,2 (2 technologies)
		SPCC Line Haul	SLHC(I,J) I = 1,13 J = 1,2 (2 technologies)
		SPCC Mux Technology Density	SMA2(I,J) I = 1,15 15 years J = 1,2 (2 technologies)
		SPCC Circuits Technology Density	SCA2(I,J) I = 1,15 15 years J = 1,2 (2 technologies)

Keyword	Description	Variable Name & Array Structure
	SPCC Line Haul Technology Density	SLA2(I,J) I = 1,15 15 years J = 1,2 (2 technologies)
TESTEQ	- Test Equipment Expense	
	Test Factor	TESTF
	Line Haul Test Expense	LHTEST(I) I = 1 N&T Carrier Expense I = 2 L&R Carrier Expense
	End Terminal Mux Test Expense	EMTEST(I) I = 1,10 Test expense for ten route bands
TAXES	- Tax Constants	TAXC(I,J) I = 1 γ_1 I = 2 γ_2 I = 3 Inflation rate I = 4 Inflation rate of change J = 1 Baseline data for non-SPCC services J = 2 Baseline data for SPCC services J = 3 Reserved for user scenario input
	Tax Variables	TAXV(I,J,K) I = 1,15 15 years J = 1 Debt ratio J = 2 Debt interest J = 3 Return on equity J = 4 Effective tax rate K = 1 Non-SPCC services K = 2 SPCC service
NODEL	- Node Switching (up to 500 lines)	
NODEU	- Node Switching (501 to 1,000 lines)	
	Equipment	EQUIP (I,J) I = 1,13 J = 1 up to 500 lines J = 2 501 - 1,000 lines

Keyword	Description	Variable Name & Array Structure
	Operator Positions	OPPOS(I,J) I = 1,13 J = 1 up to 500 lines J = 2 500 - 1,000 lines
	Software	SOFTW(I,J) I = 1,13 J = 1 Common Equipment Feature Software J = 2 Special Local Feature Software J = 3 Advanced Network Feature Software
	Trunks	TRNK(I,J) I = 1,13 J = 1 Trunks for up to 500 line service J = 2 Trunk A for 500 - 1,000 line service J = 3 Trunk B for 500 - 1,000 line service J = 4 Trunk C for 500 - 1,000 line service
	Lines	LINES(I,J) I = 1,13 J = 1 up to 500 line service J = 2 500 - 1,000 line service
WESTUN -	Western Union Satellite	WESTUN(I,J) I = 1,13 J = 1 Space Station Costs J = 2 Terrestrial Station Costs
ZZZZZZ -	End of Data Base Sentinel	

3.4 INSPEC

3.4.1 Overview of Logic

Using a pointer to the question and a code that controls the manner in which the question is asked, this routine branches to the appropriate question and solicits user input. If the user response is within proper bounds, control is returned to the calling routine. Otherwise the question is asked again.

3.4.2 Variables

Key variables used in the INSPEC subroutine are as follows:

- IGO - pointer to 1 of 14 questions (see listing below)
- ICODE - coded information used to format the question

IGO	Question Asked	Use of ICODE	Answer Stored In
1	Number of Terminals	Upper limit of answer	NTM
2	Type of Terminal	None	TYT
3	Class of Service	None	CLS
4	Type of Service -- Direct Distance Dial or Operator-Assisted	None	TOS
5	Type of Service 30 baud 150 baud	None	TOS
6	Type of Service	ICODE = 1, Voice Schedule I, II, or III ICODE = 2, Data Schedule I, II, or III ICODE = 3, City-Density Schedule (A-A), (A-B), (B-B)	TOS
7	Type of Service 2.4 Kbps 4.8 Kbps 9.6 Kbps 5.6 Kbps 1.5 Kbps	None	TOS
8	Type of Service 60 Channel 240 Channel	None	TOS

IGO	Question Asked	Use of ICODE	Answer Stored In
9	Number of Miles	None	MIL
10	Duration of Service in Minutes	None	TIM
11	Number of Trunks	ICODE = Maximum number of trunks divided by 100.	
		If ICODE <350 trunks are for <500 line service	TRK(1)
		If ICODE >350 trunks are for 501 - 1,000 line service	
		Trunk A	TRK(2)
		Trunk B	TRK(3)
		Trunk C	TRK(4)
12	Number of Lines	ICODE = Maximum number of lines divided by 100.	
		For Service #12 (<500 lines) maximum lines = minimum of TRK(1) and 500.	LIN
		For Service #13 (501 to 1,000 lines) maximum lines = minimum of: $\sum_{i=2}^{4}$ TRK(i) and 1,000	LIN
13	Number of Operator Positions	ICODE = maximum number of positions	OPR
14	Network Software Desired	ICODE = 1 - common equipment feature software	SFT(1)
		ICODE = 2	
		a) Special local feature software	SFT(2)
		b) Advanced network feature software	SFT(3)

3.5 PRINTC

3.5.1 Overview of Logic

Depending on the value of an argument passed in from TELCOM, one of two print statements is executed. Control is then returned to the calling routine.

3.5.2 Variables

Key variables used in the PRINTC subroutine are as follows:

- IP   IP = 1   Print summary cost subtotals

  IP = 2   Print detailed cost subtotals

- Values printed (see COSTA for detailed description of values):
  - IP = 1 X_{CC}, X_{CE}, Y_{CC}, Y_{CE}, X_E, TOTALS
  - IP = 2 B_{CF}, B_{CL}, X_{CC}, X_{CE}, Y_{CC}, Y_{CE}, B_R, $F_C X_{CC}$, $F_E X_{CE}$, Φ, X_E, TOTALS

3.6 EXCHANG

3.6.1 Overview of Logic

Cost vectors associated with exchange service are successively handed to the cost subroutine for cost computation. Cost elements with associated technology densities are controlled with DO loops where the cost vector and associated technology density factor are indexed by the DO loop index. Control is returned to the calling routine after all cost vectors have been processed.

3.6.2 Variables

Name	Description or Associated Parameters
BTKT	TYT, NTM
TWRB	CLS
ALRB	CLS, LAA4
ALVEM	Voice conducting, exchange vector (ALVE)
ETRB	CLS, ETA3
LSRB	CLS, LSA3

3.6.3 Equations

Building block equations for exchange service are as follows:

- Residence

  (0 or 1) (BTE or KTE) + 1 TWRE + 1 ALRE + 1 ALVE + 1 ETRE + 1 LSRE

- Business

  (0 or 1) (BTE or KTE) + 1 TWBE + 1 ALBE + 1 ALVE + 1 ETBE + 1 LSBE

3.7 MESSAG

3.7.1 Overview of Logic

Cost vectors associated with message service are passed to the cost subroutines for cost computation. DO loops control indexing for cost vectors having associated technology density functions. Subroutine MILEAG provides the index to the cost vector for the mileage range associated with mileage-dependent costs. It also provides the straight-line interpolation factor used to calculate costs for mileages not falling exactly on mileage range boundaries. If the mileage falls in the lowest range (e.g., 0 to 25 miles), a dummy cost vector with zero cost entries is used to provide the straight-line interpolation. Subroutine BANDNO provides the air band index for which route-band costs and density functions will be calculated. Control is returned to the calling program after all cost vectors have been processed.

3.7.2 Variables

Key variables used in the MESSAG subroutine are as follows:

Name	Description or Associated Parameters
BTKTM	TYT, NTM
TWRBM	CLS
ALRBM	CLS, LAA4
ALVEM	Voice conducting, message vector (ALVM)
ETRBM	CLS, ETA3
LSMDO	TOS, LSA3
TSMDST	-
IHI	Pointer to cost vector of upper end of mileage range
RMIL	Ratio of mileage (MIL) to range in which it falls
DUMMY	Zero cost vector used to interpolate between zero and first mileage range
TSM	TSA2, TIM
LOW	Pointer to cost vector of lower end of mileage range when mileage is in second or higher range.
AIRDST	Table of air band mileage ranges
IB	Band number in which service mileage falls
LHM	LHA2, LHBND, TIM
EMM	EMA2, EMBND, MIL, TIM
IMM	IMA2, IMBND, MIL, TIM

3.7.3 Equations

Building block equations for message service are as follows:

- Residence

  (Ø, 1, or 2) (BTM or KTM) + 2 TWRM + 2 ALRM + 2 ALVM + 2 ETRM

  + 2 (LSMD or LSMO) + 1 TSM + 1 LHM + 2 EMM + 1 IMM

- Business

  (Ø, 1, or 2) (BTM or KTM) + 2 TWBM + 2 ALBM + 2 ALVM + 2 ETBM

  + 2 (LSMD or LSMO) + 1 TSM + 1 LHM + 2 EMM + 1 IMM

3.8 WATS

3.8.1 Overview of Logic

This subroutine successively hands cost vectors to the cost calculation subroutines. DO loops control cost vectors having an associated technology density function by passing the cost vector for a given technology along with the technology density factor to the cost subroutine. The mileage subroutines and band number subroutine are used to obtain percent of miles in a mileage-interval and air-band number, respectively. Control is returned to calling routine after all calculations have been accomplished.

3.8.2 Variables

Key variables used in the WATS subroutine are as follows:

Name	Description or Associated Parameters
IO	Argument passed to WATS
	IO = 1 for OUTWATS
	IO = 2 for INWATS
BTKT	TYT, NTM
TWRB	CLS
TWIW	--
ALOIW	IO, LAA4
ETOIW	IO
LSOIW	IO, LSA3
TSMDST	Mileage ranges for TSM
RMIL	Ratio of mileage to mileage interval in TSMDST
IHI	Pointer to upper end of mileage range

Name	Description or Associated Parameters
DUMMY	Zero vector used for interpolation in lowest mileage range
TSOIW	IO, IHI, RMIL, TSA2
LOW	Pointer to lower end of mileage range
AIRDST	Table of air band mileage ranges
IB	Pointer to air band number
LHOIW	IO, LHA2, SCH
EMOIW	IO, EMA2, SCH, MIL
IMOIW	IO, IMA2, SCH, MIL

3.8.3 Equations

Building block equations for WATS service are as follows:

- OUTWATS

  (Ø or 1) (BTE or KTE) + 1 TWBE + 1 ALOW + 1 ETOW + 1 LSOW

  + 1 TSOW + 1 LHOW + 2 EMOW + 1 IMOW

- INWATS

  (Ø or 1) (BTE or KTE) + 1 TWIW + 1 ALIW + 1 ETIW + 1 LSIW

  + 2 TSIW + 1 LHIW + 2 EMIW + 1 IMIW

3.9 PLASBV

3.9.1 Overview of Logic

This subroutine successively passes cost vectors for each building block in private-line subvoice service to the cost calculation subroutines. DO loops control vectors that have an associated technology density function. Subroutine MILEAG is used to determine the mileage range and interpolation factor for subvoice intercity line-haul calculations. Costs for subvoice intercity line haul above 1,750 (the highest mileage range for this building block) assume linear extrapolation of costs above 1,750 miles. That is, costs for 2,625 miles of intercity line-haul are calculated at 50 percent more than costs for 1,750 miles. Control is returned to the calling routine after all cost vectors have been processed.

3.9.2 Variables

Key variables used in the PLASBV subroutine are as follows:

Name	Description or Associated Parameters
TWRB	Business vector only (TWBE)
ALSV	TOS, LAA3

Name	Description or Associated Parameters
ETSV	TOS
LHSVDS	Table of subvoice line haul mileage ranges
RMIL	Interpolation or extrapolation factor
IHI	Pointer to high end of mileage range in which mileage falls
DUMMY	Zero cost vector used to interpolate within lowest mileage range
LHSV	IHI, TOS
LOW	Pointer to low end of mileage range in which mileage falls

3.9.3 Equations

The building block equation for private-line subservice is as follows:

2 TWBE + 2 ALSV + 2 ETSV + 1 LHSV

3.10 PLAVFX

3.10.1 Overview of Logic

This subroutine controls calculation of private-line analog voice and private-line analog foreign exchange services. The two services contain the same building blocks and differ only in the quantity of the blocks. Cost vectors are successively handed to the cost calculation subroutines using DO loops to control cost calculations involving technology and route-band density functions. Cost calculations for LHPL, EMPL, and IMPL require test equipment calculations in the cost subroutine to compute M&R expenses. This is controlled by the switch BRSW in COMMON block CONTRL. Control is returned to the calling routine after all calculations are accomplished.

3.10.2 Variables

Key variables used in the PLAVFX subroutine are as follows:

Name	Description or Associated Parameters
U	Number of units of a particular building block
	For Voice Service (ISVC = 6) U = 2
	For Foreign Exchange Service (ISVC = 7) U = 1
BTKT	NTM, TYT
TWRB	Business vector (TWBE), U

Name	Description or Associated Parameters
ALPL	LAA3, U
ALVE	U
ETPL	U
AIRDST	Table of air band mileage ranges
IB	Band number in which service mileage (MIL) falls
BRSW	Switch controlling test equipment calculations in the cost subroutines BRSW = 1 for test equipment calculations, BRSW = Ø for normal calculations
LHPL	LHA2, LHBND, IB, SCH, MIL
EMPL	EMA2, EMBND, IB, SCH, MIL
IMPL	IMA2, IMBND, IB, SCH, MIL

3.10.3 Equations

Building block equations for voice and foreign exchange services are as follows:

- Private-line analog voice

  (Ø, 1 or 2) (BTE or KTE) + 2 TWBE + 2 ALPL + 2 ALVE + 2 ETPL + 1 LHPL + 2 EMPL + 1 IMPL

- Private-line analog foreign exchange

  (Ø or 1) (BTE or KTE) + 1 TWBE + 1 ALPL + 1 ALVE + 1 ETPL + 1 LHPL + 2 EMPL + 1 IMPL

3.11 PLADAT

3.11.1 Overview of Logic

This subroutine passes to the cost routines the cost vectors necessary to calculate private-line analog data costs. Three components of the MTE cost vector, CE(n), NB_C(n), and NB_E(n), vary with time (see COSTA for description of variables). These components are moved into the MTE cost vector prior to passing it to the cost calculation routine. Cost vectors with associated technology and route band densities are passed to the cost subroutines under control of a DO loop. For three building blocks, LHOL, EMDL, IDC, BRSW is set (turned on) to enable test equipment cost calculations. Control is returned to calling routine after all costs are calculated.

3.11.2 Variables

Key variables used in the PLADAT subroutine are as follows:

Name	Description or Associated Parameters
MTEY	Table of CE, NB_C, and NB_E cost data for each model year (1980 - 1994)
MTE	NTM
TWRB	Business vector (TWBE)
ALPL	LAA3
ALDE	-
ETPL	-
AIRDST	Table of air band mileage ranges
IB	Band number in which mileage falls
MIL	Mileage for requested service
BRSW	Switch to enable test equipment cost calculation BRSW = 1 enables test equipment calculation BRSW = 2 disables test equipment calculation
LHDL	LHA2, SCH, IB, MIL
EMDL	EMA2, SCH, IB, MIL
IMDL	IMA2, SCH, IB, MIL

3.11.3 Equation

The building block equation for private-line analog data service is as follows:

(Ø, 1, or 2) MTE + 2 TWBE + 2 ALPL + 2 ALDE + 2 ETPL + 2 LHDL
+ 2 EMDL + 1 IMDL

3.12 PLDIGT

3.12.1 Overview of Logic

This subroutine successively passes cost vectors to the cost routines to calculate private-line digital service costs. Subroutine MILEAG is called to convert mileage (MIL) to a mileage range pointer and interpolation factor for cost vectors associated with LHD and ITD. Control is returned to the calling program after all cost calculations are complete.

3.12.2 Variables

Key variables used in the PLDIGT subroutine are as follows:

Name	Description or Associated Parameters
LAD	TOS
ETD	TOS
EMD	TOS
LHDDST	Table of line-haul mileage ranges
IHI	Pointer to cost vector for upper end of object mileage range
RMIL	Interpolation factor for object mileage range
DUMMY	Zero cost vector used for interpolation in lowest mileage range
LOW	Pointer to cost vector for lower end of object mileage range
LHD	TOS, IHI, LOW, RMIL
ITD	TOS, IHI, LOW, RMIL

3.12.3 Equation

The building block equation for private-line digital service is as follows:

2 LAD + 2 ETD + 1 LHD + 2 EMD + 1 ITD

3.13 PLBULK

3.13.1 Overview of Logic

This subroutine controls cost calculations for bulk private-line services by successively passing cost vectors to the cost subroutines. Cost vectors with associated technology or route band density functions are controlled by DO loops. Subroutine BANDNO is called to provide a pointer to the appropriate air band for the object mileage. Control is returned to the calling routine after cost calculations are completed.

3.13.2 Variables

Key variables used in the PLBULK subroutine are as follows:

Name	Description or Associated Parameters
BTKT	TYT, NTM
TWRB	Business vector (TWBE)

Name	Description or Associated Parameters
ALVP	--
ALPL	LAA3
ETRB	Business vector (ETBE)
AIRDST	Table of air band mileage ranges
IB	Pointer to object mileage range (air band)
LHTCD	TOS, LHBND, IB
EMTCD	TOS, LHBND, IB, MIL
IMTCD	TOS, LHBND, IB, MIL

3.13.3 Equations

Building block equations for bulk private-line are as follows:

- 60 channel service

  (Ø, 1, or 2) (BTE or KTE) + 2 TWBE + 2 ALPL + 2 ALVP + 2 ETBE + 2 LHTC + 2 EMTC + 1 IMTC

- 240 channel service

  (Ø, 1, or 2) (BTE or KTE) + 2 TWBE + 2 ALPL + 2 ALVP + 2 ETBE + 1 LHTD + 2 EMTD + 1 IMTD

3.14 WIDEBD

3.14.1 Overview of Logic

Cost vectors necessary to compute wideband service costs are passed to the cost control subroutines. Subroutine MILEAG provides the pointer to the appropriate air band mileage range cost vector and the interpolation factor used to calculate wideband line haul costs. Control is returned to the calling routine after all cost vectors are processed.

3.14.2 Variables

Key variables used in the WIDEBD subroutine are as follows:

Name	Description or Associated Parameters
AL48V	TOS
ET48V	TOS
EM48V	TOS
LH48VD	Table of wideband mileage ranges
DUMMY	End cost vector used for interpolation in lowest mileage range

Name	Description or Associated Parameters
IHI	Pointer to cost vector for upper end of object mileage range
LOW	Pointer to cost vector for lower end of object mileage range
RMIL	Mileage interpolation factor
LH48V	TOS, RMIL, IHI, LOW

3.14.3 Equations

Building block equations for wideband are as follows:

- 48 kHz service

  2 AL48 + 2 ET48 + 1 LH48 + 2 EM48

- Video service

  2 ALVD + 2 ETVD + 1 LHVD + 2 EMVD

3.15 NODESW

3.15.1 Overview of Logic

Depending on an integer variable passed to this subroutine, the cost of node switching for less than 500 line service or 500 to 1,000 line service is computed. For less than 500 line service, a single cost vector for each component of the service is passed one at a time to the cost calculation routine. For 500 to 1,000 line service, cost vectors for three kinds of trunks and two kinds of software are indexed by DO loops that control the calculation of these component costs. Cost vectors for components that the user has not selected are not passed to the cost calculation subroutine. For example, if advanced network feature software was not selected by the user as a component of 500 to 1,000 line service, its associated costs are not computed.

3.15.2 Variables

Key variables used in the NODESW subroutine are as follows:

Name	Description or Associated Parameters
I	Passed to NODESW If I = 1, service is <500 lines If I = 2, service is 500 to 1,000 lines
EQUIP	I
OPPOS	I, OPR
LINES	I, LIN

Name	Description or Associated Parameters
IEND	Loop termination control for trunk and software cost vectors If I = 1, IEND = 1 for trunk control IEND = 1 for software control If I = 2, IEND = 4 for trunk control IEND = 3 for software control
TRK	TRK(1) - number of trunks for <500 line service TRK(2), TRK(3), TRK(4) - number of type A, B, and C trunks, respectively, for 500 to 1,000 line service
TRNK	I, IEND, TRK
SFT	SFT(1) - non-zero value if common equipment software is included in <500 line service SFT(2) - non-zero value if special local feature software is included in 500 to 1,000 line service SFT(3) - non-zero value if advanced network feature software is included in 500-1,000 line service
SOFTW	I, IEND, SFT

3.15.3 Equations

Building block equations for the node switching service are as follows:

- Less than 500 lines

  $EQUIP + OPR(OPPOS) + LIN(LINES) + TRK(TRNK) + SFT_1(SOFTW_1)$

- 500 to 1,000 lines

  $EQUIP' + OPR'(OPPOS') + LIN'(LINES') + TRKA(TRNKA) + TRKB(TRNKB)$

  $+ TRKC(TRNKC) + SFT_2(SOFTW_2) + SFT_3(SOFTW_3)$

  where

  ´(prime) = cost vector for 500 to 1,000 line service

  A,B,C postfix on TRK and TRNK = 500 to 1,000 link trunk cost data described in Section 3.15.2

  1,2,3 subscripts on SFT and SOFTW = software cost data described in Section 3.15.2

For less than 500 line service

LIN $\leq$ 400; TRK $\leq$ 200; LIN + TRK <500

For 500 to 1,000 line service

LIN $\leq$ 800; TRKA + TRKB + TRKC $\leq$ 800;

500 $\leq$ LIN + TRKA + TRKB + TRKC $\leq$ 1,000

3.16 SPCCPL

3.16.1 Overview of Logic

Cost vectors for the components of SPCC point-to-point private-line service are successively passed to the cost calculatio.: subroutines. DO loops control indexing for cost vectors with associated technology density functions. Control is returned to the calling routine after all cost vectors have been processed.

3.16.2 Variables

Key variables used in the SPCCPL subroutine are as follows:

Name	Description or Associated Parameters
BTKT	TYT, NTM
TWRB	Business vector (TWBE)
ALPL	LAA3
ETRB	Business vectors (ETBE), ETA3
ALVP	-
SMUX	SMA2
SCKS	SCA2
SLHC	SLA2, MIL

3.16.3 Equation

The building block equation for SPCC service is as follows:

(Ø, 1 or 2) (BTE or KTE) + 2 TWLE + 2 ALPL + 2 ALVP + 2 ETBE

+ 1 SMUX + 1 SCKS + 1 SLHC

3.17 MCIPPL

3.17.1 Overview of Logic

Cost vectors necessary to compute MCI point-to-point private-line service are successively handed to the cost calculation routines. DO

loops control indexing for those component vectors that have an associated technology density function. Control is returned to the calling routine after all cost vectors have been processed.

3.17.2 Variables

Key variables used in the MCIPPL subroutine are as follows:

Name	Description or Associated Parameters
BTKT	TYT, NTM
TWRB	Business vector (TWBE)
ALPL	LAA3
ETRB	Business vector (ETBE), ETA3
ALVP	--
MMUX	MCIA2
MLHC	MCIA2, MIL

3.17.3 Equation

The building block equation for MCI point-to-point private-line service is as follows:

(Ø, 1 or 2) (BTE or KTE) + 2 TWBE + 2 ALPL + 2 ALVP + 2 ETBE
+ 1 MMUX + 1 MLHC

3.18 ENFIA

3.18.1 Overview of Logic

This subroutine passes cost vectors that make up ENFIA service to the cost subroutines. DO loops are used to index cost vectors having associated technology density functions. There are no user-input service dimensions associated with this service. Control is returned to the calling routine after all cost vectors are processed.

3.18.2 Variables

Key variables used in the ENFIA subroutine are as follows:

Name	Description or Associated Parameters
BTKT	Basic terminal vector (BTE)
TWRB	Business vector (TWBE)

Name	Description or Associated Parameters
ALRB	Business vector (ALBE), LAA4
ALVEM	Access line voice conducting vector (ALVE)
LSOIW	Local switching OUTWATS vector (LSOW), LAA3
ETRB	Exchange trunk business vector (ETBE)
ETOIW	Exchange trunk OUTWATS vector (ETOW)

3.18.3 Equation

The building block equation for ENFIA service is as follows:

1 BTE + 1 TWBE + 1 ALBE + 1 ALVE + 1 ETOW + 1 LSOW + 1 ETBE

3.19 SATCOM

3.19.1 Overview of Logic

This subroutine controls cost calculations of Western Union satellite service by successively passing associated cost vectors to the cost calculation subroutines. DO loops control the indexing for cost vectors having associated technology density functions. There are no user-input service dimensions associated with this service. Control is returned to the calling routine after all cost vectors have been processed.

3.19.2 Variables

Key variables used in the SATCOM subroutine are as follows:

Name	Description or Associated Parameters
BTKT	Basic terminal vector (BTE)
TWRB	Terminal wire business vector (TWBE)
ALPL	LAA3
ETRB	Exchange trunk business vector (ETBE), ETA3
ALVP	--
WESTUN(1,1)	Satellite link cost vector (SLINK)
WESTUN(1,2)	Earth terminal cost vector (ETERM)

3.19.3 Equation

The building block equation for Western Union satellite service is as follows:

1 BTE + 1 TWBE + 1 ALPL + 1 ETBE + 1 ALVD + 1 SLINK + 1 ETERM

3.20 MILEAG

3.20.1 Overview of Logic

The object mileage is compared to each mileage range upper value until a condition exists where the object mileage is less than or equal to an upper range value. This determines the mileage range for which associated mileage-dependent cost vectors will be evaluated. The interpolation factor is then computed as the ratio of the portion of mileage falling within the selected mileage range to the number of miles in the selected range. If the object mileage is greater than the upper mileage in the last (highest) mileage range, the interpolation factor (which is really an extrapolation factor) is computed as the ratio of the portion of mileage falling above the highest range value to the total miles represented by the highest mileage range upper value.

3.20.2 Variables

Key variables used in the mileage subroutine are as follows:

Name	Description or Associated Parameters
MIL	User-specified object mileage (integer)
XMIL	Floating point equivalent to MIL for use in computations
N	Number of mileage range values in mileage range table (i.e., size of the table)
TABL	The mileage range table containing upper end values of mileage ranges
IHI	The computed pointer to the upper end of the object mileage range
RMIL	Mileage interpolation factor

3.20.3 Equations

The equations used to calculate the MILEAG interpolation factor are as follows:

- Interpolation factor for mileages in lowest range

$$RMIL = \frac{XMIL}{TABL(1)}, \text{ where } TABL(1) = \text{upper mileage in lowest range}$$

- Interpolation factor for mileages in any range above the first

$$RMIL = \frac{XMIL-TABL_U}{TABL_U-TABL_L}, \text{ where } TABL_U = \text{upper mileage of object range and}$$

$$TABL_L = TABL_L = \text{upper mileage of next lower range}$$

- Interpolation factor for mileages falling above the highest range

$$RMIL = \frac{XMIL-TABL_U}{TABL_U}, \text{ where } TABL_U = \text{upper mileage of highest range}$$

3.21 BANDNO

3.21.1 Overview of Logic

This subroutine compares the object mileage with table values for the upper end of air band mileage ranges. When the object mileage is found to be less than or equal to an upper range value, the air band number is determined. Air band number is the positional location of the object upper range value in the table. It should be noted that while air bands and route bands are normally numbered from zero through 9, for purposes of indexing a FORTRAN array that contains band-related data, the band numbers used are correspondingly 1 through 10, since zero is not a valid FORTRAN index.

3.21.2 Variables

Key variables used in the BANDNO subroutine are as follows:

Name	Description or Associated Parameters
MIL	Object mileage specified by the user
N	Number of entries in the mileage range table
TABL	The mileage range table containing upper mileages for air bands zero through 9
IBND	Band number in which object mileage falls; this number has an integer value in the range [1,10]

3.22 COSTA

3.22.1 Overview of Logic

This subroutine computes the five projected costs shown in Table A-2, using cost vectors and related parameters passed to the subroutines and located in the COMMON blocks. Costs for X_{CC} and X_E are computed in two and four separate parts, respectively, as shown in the equations. This provides for the user option to output detailed or summary component cost subtotals. Each time COSTA is called it computes the projected costs for only one cost vector. Thus COSTA must be called once for each technology associated with a service component. COSTA is likewise called once for each route-band cost vector associated with a service component, or a total of 10 times to compute costs associated with route bands and route-band density functions.

If switch BRSW is turned on, unique M&R costs, called test expense costs, are calculated. There are 3 types: investment-related, terminal-related, and mileage-related. Investment-related test expense is applicable only to LHPL, LHDL, EMPL, EMDL, IMPL, and IMDL costs. Terminal-related test expense is applicable only to EMPL and EMDL costs. Mileage-related test expense is applicable only to LHPL and LHDL costs. After all object costs are calculated, the results are accumulated in arrays in COMMON block ANSWER, and control returns to the calling routine. Table A-3 shows which services use this cost routine.

3.22.2 Variables

Key variables used in the COSTA subroutine are as follows:

Name	Description or Associated Parameters
V	The cost vector. See Table A-4 for cost data structure of array V.
A	The technology density factor for the cost vector. If a technology density function does not exist, A = 1.
B	The route band density factor for the route band cost vector. B = 1 if not applicable.
M	Mileage. M = 1 if mileage is not applicable.
T	Time (duration of service). T = 1 if not applicable.
U	Number of building block units of this service component that are entered in the service building block equation.

Name	Description or Associated Parameters
C	Pointer to the answer array position used to accumulate this type of component cost. See Table A-5 for list of components and respective answer array locations.
F	Single multiplication factor composed of technology density factor, route-band density factor, and mileage. F is used solely to reduce the number of multiplication operations required in the cost calculations.
TU	Like F above, this single multiplier is used to save multiplication operations. It is a combination of units of time (T) and units of the service component (U).
RU	Converted floating point value for U. This is used to save conversions from integer to floating point form.
D(J)	User-input delta inflation factors that are added to I_{CF}, I_{CL}, and I_R. J = 1, delta I_{CF} J = 2, delta I_{CL} J = 3, delta I_R
Y	Inflation index. This is the sum of age of data and number of years beyond 1980 for which costs are to be inflated.
XCCBCF	B_{CF} portion of X_{CC} costs
XCCBCL	B_{CL} portion of X_{CC} costs
XCEINT	Intermediate value of X_{CE}, which is accumulated into the answer array.
YCCINT	Like XCEINT, an intermediate value for Y_{CC}
YCEINT	Like XCEINT, an intermediate value for Y_{CE}
XEBR	B_R portion of X_E costs
XEFC	F_C portion of X_E costs
XEFE	F_E portion of X_E costs
XEPHI	FIT/ROR-related portion of X_E
XCC(I,C)	Answer array for XCC costs. C as above. I = 1, XCCBCF costs I = 2, XCCBCL costs I = 3, total XCC costs
XCE(C)	Answer array for XCE costs. C as above.
YCC(C)	Answer array for YCC costs. C as above.
YCE	Answer array for YCE costs. C as above.

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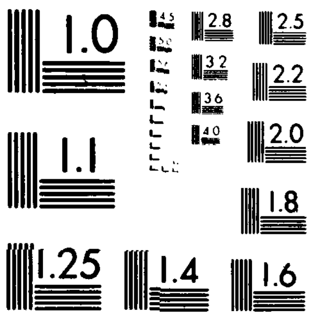

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

Name	Description of Associated Parameters
XE(I,C)	Answer array for XE costs. C as above. I = 1, XEBR costs I = 2, XEFC costs I = 3, XEFE costs I = 4, XEPHI costs I = 5, total XE costs

3.22.3 Equations

In general, the five object equations are as follows:

$$Y_{CC} = B_{CF}(1 + I_{CF})^{Y} + B_{CL}(1 + I_{CL})^{Y} \quad (1)$$

$$X_{CE} = \frac{1}{CE} X_{CC} \quad (2)$$

$$Y_{CC} = NB_{C} X_{CC} \quad (3)$$

$$Y_{CE} = NB_{E} X_{CE} \quad (4)$$

$$X_{E} = Z_{R} B_{R}(1 + I_{R})^{Y} + F_{C} X_{CC} + F_{E} X_{CE} + \Phi Y_{CE} \quad (5)$$

Equation 1 can be stated as XCC = XCCBR + XCCBF, and Equation 5 can be stated as XE = XEBR + XEFC + XEFE + XEPHI, thus providing the detailed component subtotal costs.

For cost vectors having associated technology and/or route band density functions, the three data elements must be appropriately factored. Therefore, the terms B_{CF}, B_{CL}, and B_R can be rewritten in Equations 1 and 5 as $\alpha_i\, b_i\, B_{CL}$, $\alpha_i\, b_i\, B_{CF}$, and $\alpha_i\, b_i\, B_R$. In addition, cost vectors, whose cost elements are per-unit mile, must also convert the cost data elements from unit miles to service miles. Thus, B_{CF}, B_{CL}, and B_R become $\alpha_i\, b_i\, MB_{CF}$, $\alpha_i\, b_i\, MB_{CL}$, and $\alpha_i\, b_i\, MB_R$.

The terms $(1 + I_{CF})^Y$, $(1 + I_{CL})^Y$, and $(1 + I_R)^Y$ contain no user-specified delta inflation. Array D accommodates not only the user-specified delta inflation but also includes the constant 1 portion of the inflation terms above. Therefore, the inflation terms may be written $(D(1) + I_{CF})^Y$, and $(D(3) + I_R)^Y$.

For test expense computation, the B_R portion of X_E is replaced with the following terms:

- Investment-related test expense: $B_R \times$ test factor
- Terminal-related test expense: $\alpha_i\, b_i\, B_R\, [D(3) + I_R]$
- Mileage-related test expense: $\alpha_i\, b_i\, MB_R\, [D(3) + I_R]^Y$

The final step is to accumulate each intermediate computed cost into the answer accumulators once for each unit of time and once for each building block unit. These equations are as follows:

$$XCC(1,C) = XCC(1,C) + [\alpha_i\ b_i\ MB_{CF}\ (D(1) + I_{CF})^Y] \times TU \qquad (6)$$

$$XCC(2,C) = XCC(2,C) + [\alpha_i\ b_i\ MB_{CL}\ (D(2) + I_{CL})^Y] \times TU \qquad (7)$$

$$XCE(C) = XCE(C) + [\frac{1}{CE}\ X_{CC}] \times TU \qquad (8)$$

$$YCC(C) = YCC(C) + [NB_C\ X_{CC}] \times U \qquad (9)$$

$$YCE(C) = YCE(C) + [NB_E \times X_{CE}] \times U \qquad (10)$$

$$XE(1,C) = XE(1,C) + [XEBR] \times TU \qquad (11)$$

where

$XEBR$ for non-test expense $= \alpha_i\ b_i\ MB_R\ Z_R\ [D(3) + I_R]^Y$

$XEBR$ for test expense costs = as described above

$$XE(2,C) = XE(2,C) + [F_C\ X_{CC}] \times TU \qquad (12)$$

$$XE(3,C) = XE(3,C) + [F_E\ X_{CE}] \times TU \qquad (13)$$

$$XE(4,C) = XE(4,C) + [\Phi\ Y_{CE}] \times TU \qquad (14)$$

The index C is the component subtotal pointer passed from the calling routine.

3.23 COSTI

3.23.1 Overview of Logic

This subroutine computes costs that are mileage-dependent and for which an exact mileage cost vector does not exist. Therefore two sets of costs are calculated, one for a cost vector related to the low end of a mileage range and one for a cost vector related to the upper end of that mileage range. The resultant set of costs is derived from straight-line interpolation between the two sets of costs. Because this is a mileage-related cost calculation, route-band density functions are not appropriate

to this subroutine. Also, test expense calculations are not required because they apply only to service components whose costs are route-band-related (see COSTA).

Costs involving cost data elements (X_{CC}, X_{CE} and X_E) are computed for both lower and upper mileage cost vectors. Then interpolated cost is calculated. This cost is finally accumulated in the appropriate answer array. Table A-3 shows which services use this cost routine.

3.23.2 Variables

Key variables used in the COSTI subroutine are as follows:

Name	Description or Associated Variables
V1	Cost vector for low end of mileage range
V2	Cost vector for upper end of mileage range
RMIL	Mileage interpolation factor
Y1	Inflation index for lower mileage cost vector
Y2	Inflation index for upper mileage cost vector
XCCBFL	B_{CF} component of X_{CC} for lower mileage cost vector
XCCBLL	B_{CL} component of X_{CC} for upper mileage cost vector
XCCBFU	B_{CF} component of X_{CC} for upper mileage cost vector
XCCBLU	B_{CL} component of X_{CC} for upper mileage cost vector
XCEML	X_{CE} cost for lower mileage cost vector
XCEMU	X_{CE} cost for upper mileage cost vector
XEBRL	B_R component of X_E for lower mileage cost vector
XEBRU	B_R component of X_E for upper mileage cost vector
XEFCL	F_C component of X_E for lower mileage cost vector
XEFCU	F_L component of X_E for upper mileage cost vector
XEFEL	F_E component of X_E for lower mileage cost vector
XEFEU	F_E component of X_E for upper mileage cost vector

3.23.3 Equations

Equations 1 through 5 of COSTA apply here, with the exception of the route-band factor. Costs are accumulated as in Equations 6 through 14 of COSTA after interpolation is accomplished. The basic interpolation equation is

$$COST_I = COST_U + RMIL\ (COST_U - COST_L)$$

where

$COST_I$ = interpolated cost

$COST_L$ = low end mileage cost

$COST_U$ = upper end mileage cost

RMIL = interpolation factor

3.24 COSTP

3.24.1 Overview of Logic

This subroutine is identical to Subroutine COSTA except it does not compute costs related to embedded capital. Also, there is no requirement to compute test-expense-related costs. COSTP is used to save the computer time necessary to compute X_{CE}, Y_{CE}, and the F_E component of X_E. Table A-3 shows which services use this cost routine.

3.24.2 Variables

See Subroutine COSTA (Section 3.22).

3.24.3 Equations

See Subroutine COSTA (Section 3.22).

Table A-1. SERVICE SPECIFICATION AND IDENTIFICATION OF CARRIER AND SERVICE INPUT OPTIONS			
Service Code	Service	Carrier	Service Options
1	Exchange	Bell operating companies or independent telcos	• Terminal equipment • Business or residential local exchange
2	Message	Bell operating companies or independent telcos	• Residence or business DDD or operator assistance • Mileage • Duration of call
3	Outward WATS	Bell operating companies	Mileage
4	Inward WATS	Bell operating companies	Mileage
5	Private Line -- Subvoice	AT&T Long Lines	• Terminal equipment • 30 Band • 75 Band
6	Private Line -- Voice	AT&T Long Lines	• Terminal equipment • Schedules 1, 2, and 3 (MPL equivalent) • Mileage
7	Private Line -- FX	AT&T Long Lines	• Terminal equipment • Schedules 1, 2, and 3 (MPL equivalent) • Mileage
8	Private Line -- Data	AT&T Long Lines	• Terminal equipment • Schedules 1, 2, and 3 • Mileage
9	Private Line -- Digital	AT&T Long Lines	• 2.4 Kbps • 4.8 Kbps • 9.6 Kbps • 56.0 Kbps • 1.544 mbps
10	Private Line -- Bulk		Terminal equipment
11	Wideband	AT&T Long Lines	• Access lines •• 48 kHz •• Video • Mileage
12	Node Switch: <500	Bell operating companies or independent telcos	• Trunks •• Type A •• Type B •• Type C • Lines (up to 500) • Advanced software features • Number of operator positions
13	Node Switch: >500	Bell operating companies or independent telcos	• Trunks •• Type A •• Type B •• Type C • Lines (up to 1,000) • Advanced software features • Network software features
14	MCI Point-to-Point	MCI	• Terminals • Circuit airline distance
15	SPCC Point-to-Point	SPCC	• Terminals • Circuit airline distance
16	ENFIA	AT&T	• Automatically synthesizes a high-traffic switched-access interconnection line between a Bell and SCC facility
17	Satellite	Western Union	• Circuit airline distance
18	Stop Run (Terminates CTC-PAM)		

Table A-2 EXPLANATION OF TERMS

Term	Description
X_{CC}	Projected current capital cost (book)
X_{CE}	Projected embedded capital cost (book)
X_E	Projected monthly expense
Y_{CC}	Projected current capital cost (net)
Y_{CE}	Projected embedded capital cost (net)
B_{CF}	Base year current cost (facilities)
B_{CL}	Base year current cost (labor)
B_R	Base year current cost (M&R)
Z_R	Base year M&R input
I_{CF}	Current cost inflation factor (facilities)
I_{CL}	Current cost inflation factor (labor)
I_R	Current cost inflation factor (M&R)
F_C	Current investment-related cost factor
F_E	Embedded investment-related cost factor
CE	Current-to-embedded cost ratio
NB_C	Net-to-book rate (current costs)
NB_E	Net-to-book rate (embedded costs)
n	Age of data relative to base year (1980)
YR	Projection year relative to 1979
α_i	Technology density for technology i
b_i	Route band factor i for route-band i
Φ or PHI	FIT/ROR factor

Table A-3. SUBROUTINE RELATIONSHIPS

Calling Sub-Routine	Called Subroutine																						
	INSPEC	READIN	TAXPHI	EXCHNG	MESSAG	WATS	PLASBV	PLAVFX	PLADAT	PLDIGT	PLBULK	WIDEBD	NODESW	MCIPPL	SPCCPL	ENFIA	SATCOM	COSTA	COSTI	COSTP	MILEAG	BANDNO	PRINTC
TELCOM	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X
INSPEC																							
READIN																							
TAXPHI																							
EXCHNG																		X					
MESSAG																		X	X		X	X	
WATS																		X	X		X	X	
PLASBV																		X	X		X	X	
PLAVFX																		X				X	
PLADAT																		X				X	
PLDIGT																		X	X		X		
PLBULK																		X				X	
WIDEBD																		X	X		X		
NODESW																		X			X		
MCIPPL																		X			X		
SPCCPL																		X					
ENFIA																		X			X		
SATCOM																							
COSTA																							
COSTI																							
COSTP																							
MILEAG																							
BANDNO																							

Notes: 1. To locate called subroutines, enter at left, read across and up.

2. To locate calling subroutines, enter at top, read down and left.

Table A-4. COST VECTOR STRUCTURE	
Array Element	Cost Data Element
V(1)	B_{CF}
V(2)	B_{CL}
V(3)	B_R
V(3)	Z_R
V(4)	I_{CF}
V(5)	I_{CL}
V(6)	I_R
V(7)	F_C
V(8)	F_E
V(9)	C_E
V(10)	NB_C
V(11)	NB_E
V(13)	n

Table A-5. COMPONENT SUBTOTAL ACCUMULATION	
Component	Index to Answer Array Accumulation
Terminals	1
Local Access	2
Local Switching	3
Toll Switching	4
Exchange Trunk	5
Line Haul	6
Intermediate Terminal Multiplexing	7
End Terminal Multiplexing	8
SPCC Multiplexing	9
SPCC Circuits	10
SPCC Line Haul	11
MCI Multiplexing	12
MCI Line Haul	13
Node Switching Equipment	14
Node Switching Operator Positions	15
Node Switching Common Equipment Software	16
Node Switching Special Local Software	17
Node Switching Advanced Network Software	18
Node Switching Trunks (Less than 500 lines)	19
Node Switching Type A Trunks	20
Node Switching Type B Trunks	21
Node Switching Type C Trunks	22
Node Switching Lines	23
Western Union Space Link	24
Western Union Earth Terminal	25
Total Object Equation Costs	26

APPENDIX B

OVERVIEW OF CTC-PAM DATA BASE

1. INTRODUCTION

The CTC-PAM model described in Appendix A uses an extensive data base of unit costs, allocation factors, unit cost baseline year or vintage, inflation ratios, and other elements necessary to perform many different types of cost projections. Appendix B describes the general structure of the CTC-PAM data base as of late May 1980. This data base is dynamic and would be updated as new inputs became available.

2. DATA BASE STRUCTURE

The data base contains one or more variable vectors depending on the type of data required for the CTC-PAM algorithm. As discussed in the text, a cost vector (see Table B-1) contains 13 cost elements, which serve as the basis for the determination of cost trends. The data base is structured to be read into the CTC-PAM by means of cost element key words. Depending on the location of the key words in the central layer of the model, the CTC-PAM branches to an appropriately formatted read statement to load the data into a properly dimensioned array. This process continues until a terminating key word (ZZZ ZZZ) is finally read. Statistical data other than the 13 element cost vectors are also contained in the data base as required by the trend analysis algorithms.

Appendix A describes the CTC-PAM cost trend algorithms and identifies the associated cost-related elements that are contained in the data base. Appendix B describes these data base cost-related elements in terms of the key word, associated variable names, and array structure. This appendix also contains the data base output, which illustrate the particular values of the various cost elements used in the CTC-PAM analysis.

Table B-1. CTC-PAM 13-ELEMENT COST VECTOR DESCRIPTION (MAY REVISION)

Element	Description
B_{CF}	Base year current cost -- facilities
B_{CL}	Base year current cost -- installation
B_R	Base year cost per unit of resource
Z_R	Allocation of base year unit of resource
I_{CF}	Current cost inflation rate for facilities
I_{CL}	Current cost inflation rate for installation
I_R	Resource cost inflation factor
F_C	Current investment-related cost factor
F_E	Embedded investment-related cost factor
C_E	Current-to-embedded cost ratio
NB_C	Net book ratio -- current
NB_E	Net book ratio -- embedded
n	Year or vintage of baseline data

Keyword	Description	Variable Name & Array Structure
BTE	- Basic Telephone	BTKT(I,1) I = 1,13
KTE	- Key Telephone	BTKT(I,2) I = 1,13
MTE	- Modem	MTE(I) I = 1,13
TWRE	- Terminal Wire Residence	TWRB(I,1) I = 1,13
TWBE	- Terminal Wire Business	TWRB(I,2) I = 1,13
TWIW	- Terminal Wire INWATS	TWIW(I) I = 1,13
BTM	- Basic Telephone per Message	BTKTM(I,1) I = 1,13
KTM	- Key Telephone per Message	BTKTM(I,2) I = 1,13
TWRM	- Terminal Wire Residence/Message	TWRBM(I,1) I = 1,13
TWBM	- Terminal Wire Business/Message	TWRBM(I,2) I = 1,13
MTEY	- CE, NB_C, NB_E for 15 Years for BTM, KTM, TWRM, TWBM Cost Vectors	MTEY(I,J) I = 1,15 years J = 1 CE J = 2 NB_C J = 3 NB_E
ALRE	- Access Line Residence	ALRB(I,J,K) I = 1,13
ALRB	- Access Line Business	J = 1 (4 technology densities) K = 1 (Residence) K = 2 (Business)

Keyword	Description	Variable Name & Array Structure
ALVE	- Access Line Voice	ALVEM(I,J) I = 1,13
ALVM	- Access Line Voice Message	J = 1 ALVE
		J = 2 ALVM
ALDE	- Access Line Data	ALDE(I) I = 1,13
ALVP	- Access Line, Private Line Voice	ALVP(I) I = 1,13
ALRM	- Access Line Residence per Message	ALRBM(I,J) I = 1,13
ALBM	- Access Line Business per Message	J = 1 ALRM
		J = 2 ALBM
AL48	- Access Line 48 KHz	AL48V(I,J) I = 1,13
ALVD	- Access Line Video	J = 1 AL48
		J = 2 ALVD
ALOW	- Access Line OUTWATS	ALOIW(I,J,K) I = 1,13
ALIW	- Access Line INWATS	J = 1,4 (4 technologies)
		K = 1 ALOW
		K = 2 ALIW
LAD	- Local Access Digital	LAD(I,J) I = 1,13
		J = 1 2.4 Kbps
		J = 2 4.8 Kbps
		J = 3 9.6 Kbps
		J = 4 56 Kbps
		J = 5 1.5 Mbps
ALPL	- Access Line Private Line	ALPL(I,J) I = 1,13
		J = 1,3 (3 technologies)
ALSV	- Access Line Subvoice	ALSV(I,J,K) I = 1,13
		J = 1,3 (3 technologies)
		K = 1 30 Baud
		K = 2 150 Baud

Keyword		Description	Variable Name & Array Structure
LAA4	-	Local Access Technology Density	LAA4(I,J) I = 1,15 (15 years)
			J = 1,4 (4 technologies)
LAA3	-	Local Access Technology Density	LAA3(I,J) I = 1,15 (15 years)
			J = 1,3 (3 technologies)
ETRE	-	Exchange Trunk Residence	ETRB (I,J,K) I = 1,13
ETRB	-	Exchange Trunk Business	J = 1,3 (3 technologies)
			K = 1 ETRE
			K = 2 ETRB
ETRM	-	Exchange Trunk Residence per Message	ETRBM(I,J,K) I = 1,13
			J = 1,3 (3 technologies)
ETBM	-	Exchange Trunk Business per Message	K = 1 ETRM
			K = 2 ETBM
ET48	-	Exchange Trunk 48 KHz	ET48V(I,J) I = 1,13
ETVD	-	Exchange Trunk Video	J = 1 ET48
			J = 2 ETVD
ETOW	-	Exchange Trunk OUTWATS	ETOIW(I,J) I = 1,13
ETIW	-	Exchange Trunk INWATS	J = 1 ETOW
			J = 2 RTIW
ETD	-	Exchange Trunk Digital	ETD(I,J) I = 1,13
			J = 1 2.4 Kbps
			J = 2 4.8 Kbps
			J = 3 9.6 Kbps
			J = 4 56 Kbps
			J = 5 1.5 Mbps
ETPL	-	Exchange Trunk Private Line	ETPL(I) I = 1,13
ETSV	-	Exchange Trunk Subvoice	ETSV(I,J) I = 1,13
			J = 1 30 Baud
			J = 2 150 Baud
ETA3	-	Exchange Trunk Technology Densities	ETA3(I,J)
			I = 1,15 (15 years)
			J = 1,3 (3 technologies)

Keyword	Description	Variable Name & Array Structure
LSRE	- Local Switching Residence	LSRB(I,J,K) I = 1,13
LSBE	- Local Switching Business	J = 1,3 (3 technologies)
		K = 1 LSRE
		K = 2 LSBE
LSMD	- Local Switching per Message Direct Distance Dialing	LSMDO(I,J,K) I = 1,13
		J = 1,3 (3 technologies)
LSMO	- Local Switching per Message Operator-Assisted	K = 1 LSMD
		K = 2 LSMO
LSOW	- Local Switching OUTWATS	LSOIW(I,J,K) I = 1,13
LSIW	- Local Switching INWATS	J = 1,3 (3 technologies)
		K = 1 LSOW
		K = 2 LSIW
LSA3	- Local Switching Technology Densities	LSA3(I,J)
		I = 1,15 (15 years)
		J = 1,3 (3 technologies)
TSOW	- Toll Switching OUTWATS	TSOIW(I,J,K) I = 1,13
TSIW	- Toll Switching INWATS	J = 1 up to 50 miles
		J = 2 50 - 3,000 miles
		K = 1,2 TSOW technologies 1 and 2
		K = 3,4 TSIW technologies 1 and 2
TSM	- Toll Switching per Message	TSM(I,J,K) I = 1,13
		J = 1 up to 50 miles
		J = 2 51 - 3,000 miles
		K = 1,2 Fixed and mileage dependent costs, technology 1
		K = 3,4 Fixed and mileage dependent costs, technology 2
TSMDST	- Upper Mileage for Toll Switching Mileage Intervals	TSMDST(I)
		I = 1 50 miles
		I = 2 3,000 miles

Keyword	Description	Variable Name & Array Structure
TSA2	- Toll Switching Technology Densities	TSA2(I,J) I = 1,15 (15 years) J = 1,2 (2 technologies)
LHD	- Intercity Line-Haul Digital	LHD(I,J,K) I = 1,13 J = 1 up to 76 miles J = 2 77 to 163 miles J = 3 164 to 250 miles J = 4 251 to 375 miles J = 5 376 to 500 miles J = 6 501 to 750 miles J = 7 751 to 1,000 miles J = 8 1,001 to 3,000 miles K = 1 2.4 Kbps K = 2 4.8 Kbps K = 3 9.6 Kbps K = 4 56 Kbps K = 5 1.5 Mpbs
LH48	- Intercity Line Haul 48 KHz	LH48V(I,J,K) I = 1,13
LHVD	- Intercity Line Haul Video	For LH48 (K = 1) J = 1 up to 76 miles J = 2 77 to 3,000 miles For LHVD (K = 2) J = 1 up to 50 miles J = 2 51 to 3,000 miles
LHDL	- Intercity Line Haul Data	LHDL(I,J,K) I = 1,13 J = 1,10 for 10 route bands K = 1,2 Technology 1 and 2 Schedule I K = 3,4 Technology 1 and 2 Schedule II K = 5,6 Technology 1 and 2 Schedule III

Keyword	Description	Variable Name & Array Structure
LHSV	- Intercity Line Haul Subvoice	LHSV(I,J,K) I = 1,13 J = 1 up to 50 miles J = 2 51 to 175 miles J = 3 176 to 375 miles J = 4 376 to 750 miles J = 5 751 to 1,750 miles K = 1 30 baud K = 2 150 baud
LHPL	- Intercity Line Haul Private Line	LHPL(I,J,K) same as LHDL
LHTC	- Intercity Line Haul Bulk 60 Channels	LHTCD(I,J,K) I = 1,13 J = 1,10 route bands
LHTD	- Intercity Line Haul Bulk 240 Channels	K = 1 60 channels K = 2 240 channels
LHM	- Intercity Line Haul per Message	LHM(I,J,K) I = 1,13 J = 1,10 route bands K = 1,2 (2 technologies)
LHOW	- Intercity Line Haul OUTWATS	LHOIW(I,J,K) I = 1,13
LHIW	- Intercity Line Haul INWATS	J = 1,10 route bands K = 1,2 OUTWATS, 2 technologies K = 3,4 INWATS, 2 technologies
LHBND	- Route Band Densities per Air Band	LHBND(I,J,K) I = 1,10 air bands J = 1,10 route bands K = 1,3 schedules I, II, III
LHA2	- Line Haul Technology Density	LHA2(I,J,K) I = 1,10 10 route bands J = 1,2 (2 technologies) K = 1,3 schedules I, II, III
ABFCT	- Air to route miles conversion factors	ABFCT(I,J) I = 1,10 10 route bands J = 1,3 schedules I, II, III

Keyword	Description	Variable Name & Array Structure
LHDDST	- Mileage Intervals for Line Haul Variable LHD	LHDDST(I) I = 1,8 mileage intervals
LH48VD	- Mileage Interval for Line Haul Variables LH48, LHVD	LH48VD(I,J) For J = 1, I = 1,2 LH48 intervals For J = 2, I = 1,2 LHVD intervals
LHSVDS	- Mileage Interval for Line Haul Variable LHSV	LHSVDS(I) I = 1,5 5 mileage intervals
AIRDST	- Air Band Distance Table	AIRDST(I) I = 1,10 for 10 air band intervals with upper limits as follows 25, 50, 100, 150, 200, 250, 300, 500, 1,000, 3,000
EMPL	- End Terminal Multiplexing Voice	EMPL(I,J,K) same as LHPL
EMTC	- End Terminal Multiplexing Bulk 60 Channels	EMTCD(I,J,K) Same as LHTCD
EMTD	- End Terminal Multiplexing Bulk 240 Channels	
EMM	- End Terminal Multiplexing per Message	EMM(I,J,K) Same as LHM
EMOW	- End Terminal Multiplexing OUTWATS	EMOIW(I,J,K)
EMIW	- End Terminal Multiplexing INWATS	Same as LHOIW
EMD	- End Terminal Multiplexing Digital	EMD(I,J) Same as LHD
EMDL	- End Terminal Multiplexing Data	EMDL(I,J,K) Same as LHDL
EM48	- End Terminal Multiplexing 48 KHz	EM48V(I,J) I = 1,13
EMVD	- End Terminal Multiplexing Video	J = 1 48 KHz J = 2 Video
EMBND	- End Terminal Multiplexing Route Band Densities per Air Band	LHBND(I,J,K) Same as LHBND
EMA2	- End Terminal Multiplexing Technology Densities	EMA2(I,J,K) Same as LHA2
IMPL	- Intermediate Terminal Multiplexing Voice	IMPL(I,J,K) Same as LHPL
IMTC	- Intermediate Terminal Multiplexing Bulk 60 Channels	IMTCD(I,J,K) Same as LHTCD
IMTD	- Intermediate Terminal Multiplexing Bulk 240 Channels	
IMM	- Intermediate Terminal Multiplexing per Message	IMM(I,J,K) Same as LHM

Keyword	Description	Variable Name & Array Structure
IMOW	- Intermediate Terminal Multiplexing OUTWATS	IMOIW(I,J,K) Same as LHOIW
IMIW	- Intermediate Terminal Multiplexing INWATS	
ITD	- Intermediate Terminal Multiplexing Digital	ITD(I,J,K) Same as LHD
IMDL	- Intermediate Terminal Multiplexing Data	IMDL(I,J,K) Same as LHDL
IMPL	- Intermediate Terminal Multiplexing Voice	IMPL(I,J,K) Same as LHPL
IMA2	- Intermediate Terminal Multiplexing Technology Densities	IMA2(I,J,K) Same as LHA2
IMBND	- Intermediate Terminal Multiplexing Route Band Densities per Air Band	IMBND(I,J,K) Same as LHBND
MCI	- MCI Service	
	MCI Multiplexing	MMUX(I,J) I = 1,13 J = 1,2 (2 technologies)
	MCI Line Haul	MLHC(I,J) I = 1,13 J = 1,2 (2 technologies)
	MCI Technology Density	MCIA2(I,J) I = 1,15 15 years J = 1,2 two densities
SPCC	- SPCC Service	
	SPCC Multiplexing	SMUX(I,J) I = 1,13 J = 1,2 (2 technologies)
	SPCC Circuits	SCKS(I,J) I = 1,13 J = 1,2 (2 technologies)
	SPCC Line Haul	SLHC(I,J) I = 1,13 J = 1,2 (2 technologies)
	SPCC Mux Technology Density	SMA2(I,J) I = 1,15 15 years J = 1,2 (2 technologies)
	SPCC Circuits Technology Density	SCA2(I,J) I = 1,15 15 years J = 1,2 (2 technologies)

Keyword	Description	Variable Name & Array Structure
	SPCC Line Haul Technology Density	SLA2(I,J) I = 1,15 15 years J = 1,2 (2 technologies)
TESTEQ	- Test Equipment Expense	
	Test Factor	TESTF
	Line Haul Test Expense	LHTEST(I) I = 1 N&T Carrier Expense I = 2 L&R Carrier Expense
	End Terminal Mux Test Expense	EMTEST(I) I = 1,10 Test expense for ten route bands
TAXES	- Tax Constants	TAXC(I,J) I = 1 γ_1 I = 2 γ_2 I = 3 Inflation rate I = 4 Inflation rate of change J = 1 Baseline data for non-SPCC services J = 2 Baseline data for SPCC services J = 3 Reserved for user scenario input
	Tax Variables	TAXV(I,J,K) I = 1,15 15 years J = 1 Debt ratio J = 2 Debt interest J = 3 Return on equity J = 4 Effective tax rate K = 1 Non-SPCC services K = 2 SPCC service
NODEL	- Node Switching (up to 500 lines)	
NODEU	- Node Switching (501 to 1,000 lines)	
	Equipment	EQUIP (I,J) I = 1,13 J = 1 up to 500 lines J = 2 501 - 1,000 lines

Keyword	Description	Variable Name & Array Structure
	Operator Positions	OPPOS(I,J) I = 1,13 J = 1 up to 500 lines J = 2 500 - 1,000 lines
	Software	SOFTW(I,J) I = 1,13 J = 1 Common Equipment Feature Software J = 2 Special Local Feature Software J = 3 Advanced Network Feature Software
	Trunks	TRNK(I,J) I = 1,13 J = 1 Trunks for up to 500 line service J = 2 Trunk A for 500 - 1,000 line service J = 3 Trunk B for 500 - 1,000 line service J = 4 Trunk C for 500 - 1,000 line service
	Lines	LINES(I,J) I = 1,13 J = 1 up to 500 line service J = 2 500 - 1,000 line service
WESTUN	- Western Union Satellite	WESTUN(I,J) I = 1,13 J = 1 Space Station Costs J = 2 Terrestrial Station Costs
ZZZZZZ	- End of Data Base Sentinel	

RTE							
14.03	5.30	0.4975	1.0	0.03	0.07	0.07	0.
0.006125	1.10	0.73	0.73	3.			
KTE							
40.54	4.42	0.7425	1.0	0.03	0.07	0.07	0.01182
0.	1.10	0.73	0.73	1.			
MTE							
2451.91	67.06	64.60	1.0	0.03	0.07	0.07	0.01472
0.	0.	0.	0.	0.			
TWRE							
1.84	10.23	0.1614	1.0	0.03	0.07	0.07	0.
0.01129	1.51	1.00	1.00	3.			
TWRE							
2.01	22.34	0.2016	1.0	0.03	0.07	0.07	0.
0.01128	1.51	1.00	1.00	3.			
TWIN							
2.01	22.34	0.2016	1.0	0.03	0.07	0.07	0.
0.01128	1.51	1.00	1.00	3.			
RTM							
0.01824	0.006930	0.007761	1.0	0.03	0.07	0.07	0.
0.0735	1.10	0.73	0.73	3.			
KTM							
0.05283	0.005746	0.01159	1.0	0.03	0.07	0.07	0.1418
0.	1.10	0.73	0.73	1.			
TWRM							
0.002392	0.02370	0.002522	1.0	0.03	0.07	0.07	0.
0.1353	1.51	1.00	1.00	3.			
TWRM							
0.032513	0.02304	0.003146	1.0	0.09	0.07	0.07	0.
0.1353	1.51	1.00	1.00	3.			
MTEY							
1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07
1.08	1.09	1.10	1.10	1.10	1.10	1.10	
1.00	0.97	0.94	0.92	0.89	0.85	0.83	0.81
0.78	0.75	0.73	0.73	0.73	0.73	0.73	
1.00	0.97	0.94	0.92	0.89	0.86	0.83	0.81
0.78	0.75	0.73	0.73	0.73	0.73	0.73	
ALRE							
760.43	101.56	2.94	1.0	0.07	0.07	0.10	0.
0.003667	2.20	0.66	0.66	3.			
413.53	101.56	1.16	1.0	0.07	0.07	0.10	0.
0.001524	2.10	0.82	0.82	3.			
434.92	101.56	2.23	1.0	0.05	0.07	0.10	0.
0.003125	1.65	0.81	0.81	3.			
471.75	101.56	4.93	1.0	0.08	0.07	0.10	0.
0.01329	1.15	0.54	0.54	3.			
ALRE							
757.00	82.30	2.86	1.0	0.07	0.07	0.10	0.
0.003667	2.20	0.66	0.66	3.			
411.71	82.30	1.09	1.0	0.07	0.07	0.10	0.
0.001524	2.10	0.82	0.82	3.			
433.09	82.90	2.15	1.0	0.06	0.07	0.10	0.
0.003125	1.65	0.91	0.91	3.			
469.70	82.90	4.86	1.0	0.09	0.07	0.10	0.
0.01329	1.15	0.54	0.54	3.			
ALRM							
0.2286	0.03067	0.01061	1.0	0.07	0.07	0.10	0.
0.04400	2.20	0.66	0.66	3.			
0.1243	0.03067	0.004209	1.0	0.07	0.07	0.10	0.
0.01829	2.10	0.92	0.92	3.			
0.1308	0.03067	0.008966	1.0	0.06	0.07	0.10	0.
0.03750	1.65	0.81	0.81	3.			

AL94							
0.2286	0.0250	0.01037	1.0	0.07	0.07	0.10	0.
0.04400	2.20	0.66	0.66	3.			
0.1243	0.0250	0.003944	1.0	0.07	0.07	0.10	0.
0.01829	2.10	0.82	0.82	3.			
0.1308	0.0250	0.007401	1.0	0.06	0.07	0.10	0.
0.03750	1.65	0.81	0.81	3.			
0.1419	0.0250	0.01754	1.0	0.09	0.07	0.10	0.
0.1594	1.35	0.54	0.54	3.			
ALVE							
26.11	0.	0.184	1.0	0.06	0.	0.10	0.
0.004015	1.35	0.72	0.72	3.			
ALV4							
0.007886	0.	0.0006674	1.0	0.06	0.	0.10	0.
0.004015	1.35	0.72	0.72	3.			
AL48							
617.29	0.	5.76	1.0	0.06	0.	0.10	0.
0.0025	2.00	0.87	0.87	0.			
ALVD							
11897.	32361.	48.	1.0	0.07	0.06	0.10	0.
0.0197	1.5	0.76	0.76	5.			
ALOW							
1125.54	0.	3.77	1.0	0.07	0.	0.10	0.
0.003667	2.20	0.66	0.66	2.			
612.17	0.	1.14	1.0	0.07	0.	0.10	0.
0.001524	2.10	0.82	0.82	2.			
643.93	0.	2.72	1.0	0.06	0.	0.10	0.
0.003125	1.65	0.81	0.81	2.			
698.69	0.	6.72	1.0	0.08	0.	0.10	0.
0.01329	1.35	0.54	0.54	2.			
ALIW							
1125.54	0.	3.77	1.0	0.07	0.	0.10	0.
0.003667	2.20	0.66	0.66	2.			
612.17	0.	1.14	1.0	0.07	0.	0.10	0.
0.001524	2.10	0.82	0.82	2.			
643.93	0.	2.72	1.0	0.06	0.	0.10	0.
0.003125	1.65	0.81	0.81	2.			
698.69	0.	6.72	1.0	0.08	0.	0.10	0.
0.01329	1.35	0.54	0.54	2.			
LAD							
352.	79.	1.47	1.0	0.03	0.07	0.10	0.
0.01467	1.1	0.47	0.47	4.			
352.	79.	1.47	1.0	0.03	0.07	0.10	0.
0.01467	1.1	0.47	0.47	4.			
352.	79.	1.47	1.0	0.03	0.07	0.10	0.
0.01467	1.1	0.47	0.47	4.			
352.	79.	1.47	1.0	0.03	0.07	0.10	0.
0.01467	1.1	0.47	0.47	4.			
810.	323.	3.85	1.0	0.03	0.07	0.10	0.
0.01467	1.1	0.47	0.47	4.			
ALVP							
26.11	0.	0.184	1.0	0.05	0.	0.10	0.
0.004015	1.35	0.72	0.72	3.			
ALDE							
62.01	0.	0.437	1.0	0.06	0.	0.10	0.
0.004015	1.35	0.72	0.72	3.			
ALPL							
678.11	0.	5.00	1.0	0.07	0.	0.10	0.
0.003667	2.20	0.66	0.66	3.			
373.11	0.	1.46	1.0	0.07	0.	0.10	0.
0.001524	2.10	0.82	0.82	3.			
381.53	0.	2.66	1.0	0.06	0.	0.10	0.

0.003125	1.65	0.91	0.81	3.			
ALSV							
619.87	0.	4.57	1.0	0.07	0.	0.10	0.
0.003667	2.20	0.66	0.66	3.			
337.01	0.	1.32	1.0	0.07	0.	0.10	0.
0.001524	2.10	0.82	0.82	3.			
343.89	0.	2.40	1.0	0.06	0.	0.10	0.
0.003125	1.65	0.91	0.81	3.			
301.09	0.	2.22	1.0	0.07	0.	0.10	0.
0.003667	2.20	0.66	0.66	3.			
70.73	0.	0.29	1.0	0.07	0.	0.10	0.
0.001524	2.10	0.82	0.82	3.			
137.78	0.	0.75	1.0	0.05	0.	0.10	0.
0.003125	1.65	0.81	0.31	3.			
LAA4							
0.25	0.25	0.25	0.24	0.23	0.22	0.21	0.20
0.20	0.19	0.18	0.17	0.16	0.15	0.14	
0.52	0.52	0.51	0.51	0.51	0.51	0.50	0.50
0.53	0.49	0.49	0.49	0.48	0.48	0.48	
0.22	0.22	0.23	0.24	0.25	0.26	0.28	0.29
0.29	0.31	0.32	0.33	0.35	0.36	0.37	
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	
LAA3							
0.25	0.26	0.26	0.25	0.24	0.23	0.22	0.21
0.21	0.20	0.19	0.18	0.17	0.16	0.15	
0.52	0.52	0.51	0.51	0.51	0.51	0.50	0.50
0.53	0.49	0.49	0.49	0.48	0.48	0.48	
0.22	0.22	0.23	0.24	0.25	0.26	0.28	0.29
0.29	0.31	0.32	0.33	0.35	0.36	0.37	
ETRE							
169.43	0.	0.28	1.0	0.07	0.	0.10	0.
0.001917	2.05	0.80	0.80	3.			
36.50	0.	0.15	1.0	0.06	0.	0.10	0.
0.002977	1.70	0.76	0.76	3.			
0.	0.	0.	1.0	0.	0.	0.10	0.
0.	1.	1.	1.	3.			
ETRE							
250.90	0.	0.57	1.0	0.07	0.	0.10	0.
0.001917	2.05	0.80	0.80	3.			
54.04	0.	0.23	1.0	0.06	0.	0.10	0.
0.002977	1.70	0.75	0.76	3.			
0.	0.	0.	1.0	0.	0.	0.10	0.
0.	1.	1.	1.	3.			
ETR4							
0.05117	0.	0.001387	1.0	0.07	0.	0.10	0.
0.02301	2.05	0.80	0.80	3.			
0.01102	0.	0.0005539	1.0	0.06	0.	0.10	0.
0.01573	1.70	0.76	0.76	3.			
0.	0.	0.	1.0	0.	0.	0.10	0.
0.	1.	1.	1.	3.			
ETRM							
0.07577	0.	0.002054	1.0	0.07	0.	0.10	0.
0.02301	2.05	0.80	0.80	3.			
0.1632	0.	0.0008203	1.0	0.05	0.	0.10	0.
0.03573	1.70	0.75	0.76	3.			
0.	0.	0.	1.0	0.	0.	0.10	0.
0.	1.	1.	1.	3.			
ETVO							
2104.	0.	354.	1.0	0.05	0.	0.10	0.
0.009571	[illegible]	[illegible]	[illegible]	5.			

0.004015	1.15	0.72	0.72	2.			
ETIM							
303.18	0.	2.14	1.0	0.06	0.	0.10	0.
0.004015	1.15	0.72	0.72	2.			
ETD							
1434.	34.	6.85	1.0	0.07	0.10	0.10	0.
0.0025	2.0	0.87	0.87	4.			
1472.	34.	7.03	1.0	0.07	0.10	0.10	0.
0.0025	2.0	0.87	0.87	4.			
1486.	132.	7.55	1.0	0.07	0.10	0.10	0.
0.0025	2.0	0.87	0.87	4.			
1535.	132.	7.78	1.0	0.07	0.10	0.10	0.
0.0025	2.0	0.87	0.87	4.			
4042.	0.	18.86	1.0	0.07	0.	0.10	0.
0.0025	2.0	0.87	0.87	4.			
ET48							
6002.	0.	86.52	1.0	0.05	0.	0.10	0.
0.003593	1.15	0.82	0.82	0.			
ETPL							
222.14	41.39	1.48	1.0	0.08	0.06	0.10	0.
0.002673	1.7	0.865	0.865	3.			
ETSV							
211.12	0.	0.98	1.0	0.08	0.	0.10	0.
0.0025	2.0	0.87	0.87	3.			
211.12	175.54	2.86	1.0	0.08	0.06	0.10	0.
0.002988	1.7	0.85	0.85	3.			
ETA3							
0.82	0.80	0.78	0.76	0.74	0.72	0.70	0.68
0.65	0.64	0.62	0.60	0.58	0.55	0.54	
0.19	0.20	0.22	0.24	0.26	0.28	0.30	0.32
0.34	0.36	0.38	0.40	0.42	0.44	0.46	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	
LSRE							
443.26	11.89	4.62	1.0	0.09	0.06	0.10	0.
0.007925	2.00	0.57	0.57	3.			
309.39	11.99	4.15	1.0	0.09	0.06	0.10	0.
0.003086	1.89	0.69	0.69	3.			
320.25	11.99	5.29	1.0	0.02	0.06	0.10	0.
0.002245	1.10	0.72	0.72	3.			
LS9E							
404.94	46.16	4.79	1.0	0.09	0.06	0.10	0.
0.007925	2.00	0.57	0.57	3.			
330.64	46.16	4.51	1.0	0.09	0.06	0.10	0.
0.003086	1.39	0.69	0.69	3.			
308.85	46.15	5.54	1.0	0.02	0.06	0.10	0.
0.002245	1.10	0.72	0.72	3.			
LSMD							
0.07376	0.0134	0.01452	1.0	0.09	0.06	0.10	0.
0.09510	2.00	0.57	0.57	3.			
0.07249	0.0134	0.01490	1.0	0.09	0.06	0.10	0.
0.003704	1.90	0.69	0.69	3.			
0.05601	0.0134	0.01716	1.0	0.02	0.06	0.10	0.
0.02597	1.10	0.72	0.72	3.			
LSM3							
0.07249	.0134	.01452	1.0	.09	.06	.10	0.
0.09510	2.00	0.57	0.57	3.			
0.07247	0.0134	0.01490	1.0	0.09	0.06	0.10	0.
0.03704	1.90	0.69	0.69	3.			
0.05601	0.0134	0.01716	1.0	0.02	0.06	0.10	0.
0.02694	1.10	0.72	0.72	3.			
LS04							

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0.007925  2.00     0.57    0.57    3.
765.94    120.25   14.99   1.0     0.07    0.06    0.10    0.
0.003086  1.80     0.69    0.69    3.
705.63    120.25   12.02   1.0     0.02    0.06    0.10    0.
0.002245  1.10     0.72    0.72    3.
LSIW
749.40    110.78   8.80    1.0     0.09    0.06    0.10    0.
0.007925  2.00     0.57    0.57    3.
669.20    110.78   8.77    1.0     0.09    0.06    0.10    0.
0.003086  1.80     -.69    0.69    3.
617.17    110.78   10.58   1.0     0.02    0.06    0.10    0.
0.002245  1.10     0.72    0.72    3.
LSA3
0.046     0.042    0.0     0.0     0.0     0.0     0.0     0.0
0.00      0.00     0.00    0.00    0.00    0.00    0.00
0.734     0.698    0.5     0.4     0.3     0.2     0.1     0.0
0.0       0.0      0.0     0.0     0.0     0.0     0.0
0.22      0.26     0.5     0.6     0.7     0.8     0.9     1.0
1.0       1.0      1.0     1.0     1.0     1.0     1.0
TSOW
1093.     273.     350.    1.0     0.077   0.10    0.10    0.
0.002381  1.1      0.80    0.80    2.
1093.     273.     350.    1.0     0.077   0.077   0.10    0.
0.002381  1.1      0.80    0.80    2.
1093.     88.      350.    1.0     0.02    0.02    0.      0.
0.002381  1.1      0.80    0.80    2.
1093.     88.      350.    1.0     0.02    0.02    0.      0.
0.002381  1.1      0.80    0.80    2.
TSIW
1001.     250.     356.    1.0     0.077   0.077   0.10    0.
0.002381  1.1      0.80    0.80    2.
1001.     250.     356.    1.0     0.077   0.077   0.10    0.
0.002381  1.1      0.80    0.80    2.
1001.     88.      356.    1.0     0.02    0.02    0.      0.
0.002381  1.1      0.80    0.80    2.
1001.     88.      356.    1.0     0.02    0.02    0.      0.
0.002381  1.1      0.80    0.80    2.
TSM
0.7426    0.1854   0.28    1.0     0.077   0.077   0.10    0.
0.02857   1.1      0.80    0.80    2.
0.7426    0.1854   0.28    1.0     0.077   0.077   0.10    0.
0.02857   1.1      0.80    0.80    2.
0.7426    0.07     0.28    1.0     0.02    0.02    0.      0.
0.02857   1.1      0.80    0.80    2.
0.7426    0.07     0.28    1.0     0.02    0.02    0.      0.
0.02857   1.1      0.80    0.80    2.
0.02357   0.005907 0.03    1.0     0.077   0.077   0.10    0.
0.02857   1.1      0.80    0.80    2.
0.02357   0.005907 0.03    1.0     0.077   0.077   0.10    0.
0.02857   1.1      0.80    0.80    2.
0.02357   0.0075   0.03    1.0     0.02    0.02    0.      0.
0.02857   1.1      0.80    0.80    2.
0.02357   0.0075   0.03    1.0     0.02    0.02    0.      0.
0.02857   1.1      0.80    0.80    2.
TSMOST
50.       3000.
TSA2
0.76      0.72     0.68    0.64    0.60    0.56    0.52    0.48
0.44      0.40     0.36    0.32    0.28    0.24    0.20
0.24      0.28     0.32    0.36    0.40    0.44    0.48    0.52
0.56      0.60     0.64    0.68    0.72    0.76    0.80
LHD
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0.006417	1.62	0.71	0.71	0.			
244.	0.	1.63	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
375.	0.	2.50	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
562.	0.	3.75	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
750.	0.	5.00	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1125.	0.	7.50	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1500.	0.	10.00	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
4499.	0.	30.00	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
175.	0.	1.17	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
375.	0.	2.50	1.0	0.08	0.	0.10	0.
0.006416	1.62	0.71	0.71	0.			
575.	0.	3.83	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
863.	0.	5.75	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1150.	0.	7.67	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1725.	0.	11.50	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
2301.	0.	15.34	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
6903.	0.	46.02	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
350.	0.	2.33	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
750.	0.	5.00	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1150.	0.	7.67	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1725.	0.	11.50	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
2301.	0.	15.34	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
3451.	0.	23.00	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
4602.	0.	30.68	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
13805.	0.	92.04	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1745.	0.	11.63	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
3742.	0.	24.95	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
5737.	0.	38.26	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
8609.	0.	57.39	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
11479.	0.	76.52	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
17218.	0.	114.79	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
22957.	0.	153.05	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
68872.	0.	459.15	1.0	0.08	0.	0.10	0.

149490.	0.	830.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
320621.	0.	1780.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
491750.	0.	2730.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
737625.	0.	4095.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
885150.	0.	4914.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1475000.	0.	8190.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
1967000.	0.	10920.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
5901000.	0.	32760.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
LHVD							
88300.	0.	678.	1.0	-0.046	0.	0.10	0.
0.006417	1.30	0.85	0.85	3.			
5298000.	0.	40680.	1.0	-0.046	0.	0.10	0.
0.006417	1.30	0.85	0.85	3.			
LH48							
149490.	0.	830.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
5901000.	0.	32760.	1.0	0.08	0.	0.10	0.
0.006417	1.62	0.71	0.71	0.			
LHDL							
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.

2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
LHSV							
2760.	0.	8.85	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
4200.	0.	13.47	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
6300.	0.	20.21	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
10800.	0.	34.55	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
21000.	0.	67.37	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
5880.	0.	18.86	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
9660.	0.	30.99	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
13900.	0.	43.31	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
19830.	0.	63.52	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
37800.	0.	121.26	1.0	0.	0.10	0.10	0.
0.0019	2.0	0.75	0.75	4.			
LHPL							
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.35	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
29.01	0.	0.	1.0	-0.035	0.	0.10	0.
0.00233	1.15	0.93	0.93	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.15	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.15	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.15	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.35	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.15	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.15	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.15	0.89	0.89	2.			
2.28	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.15	0.89	0.89	2.			

0.00429	1.15	0.89	0.89	2.			
2.29	0.	0.	1.0	0.003	0.	0.10	0.
0.00429	1.15	0.89	0.89	2.			
LHTC							
489.	0.	34.	1.0	-0.016	0.	0.10	0.
0.0033	1.60	0.91	0.91	2.			
870.	0.	61.	1.0	-0.007	0.	0.10	0.
0.0038	1.50	0.90	0.90	2.			
917.	0.	68.	1.0	0.000	0.	0.10	0.
0.0041	1.44	0.894	0.894	2.			
764.	0.	65.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
1274.	0.	109.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
2038.	0.	174.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
3185.	0.	273.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
4459.	0.	382.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
7644.	0.	654.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
11456.	0.	981.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
LHTD							
489.	0.	34.	1.0	-0.016	0.	0.10	0.
0.0033	1.60	0.91	0.91	2.			
870.	0.	61.	1.0	-0.007	0.	0.10	0.
0.0038	1.50	0.90	0.90	2.			
917.	0.	68.	1.0	0.000	0.	0.10	0.
0.0041	1.44	0.894	0.894	2.			
764.	0.	65.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
1274.	0.	109.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
2038.	0.	174.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
3185.	0.	273.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
4459.	0.	382.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
7644.	0.	654.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
11456.	0.	981.	1.0	0.003	0.	0.10	0.
0.00429	1.40	0.89	0.89	2.			
LHM							
0.00132	0.	0.0000794	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			
0.00424	0.	0.000254	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			
0.00850	0.	0.000510	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			
0.0173	0.	0.00104	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			
0.0241	0.	0.00175	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			
0.0474	0.	0.00285	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			
0.0750	0.	0.00450	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			
0.108	0.	0.00649	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			

0.325	0.	0.0195	1.0	-0.035	0.	0.10	0.
0.023	2.0	0.94	0.94	2.			
0.000752	0.	0.0000564	1.0	0.003	0.	0.10	0.
0.007	1.6	0.85	0.85	2.			
0.00241	0.	0.000181	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
0.00483	0.	0.000362	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
0.00982	0.	0.000736	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
0.0166	0.	0.00124	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
0.0269	0.	0.00202	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
0.0426	0.	0.00319	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
0.0514	0.	0.00461	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
0.114	0.	0.00851	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
0.185	0.	0.01385	1.0	0.003	0.	0.10	0.
0.077	1.6	0.85	0.85	2.			
LHOW							
53.	0.	3.18	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
170.	0.	10.2	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
341.	0.	20.5	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
693.	0.	41.6	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
1168.	0.	70.1	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
1901.	0.	114.	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
3005.	0.	180.	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
4334.	0.	260.	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
8009.	0.	481.	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
13030.	0.	782.	1.0	-0.035	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
35.	0.	2.66	1.0	0.003	0.	0.10	0.
0.006417	1.6	0.85	0.85	2.			
113.	0.	8.50	1.0	0.003	0.	0.10	0.
0.006417	1.6	0.85	0.85	2.			
227.	0.	17.1	1.0	0.003	0.	0.10	0.
0.006417	1.6	0.85	0.85	2.			
462.	0.	34.7	1.0	0.003	0.	0.10	0.
0.006417	1.6	0.85	0.85	2.			
780.	0.	58.5	1.0	0.003	0.	0.10	0.
0.006417	1.6	0.85	0.85	2.			
1269.	0.	95.2	1.0	0.003	0.	0.10	0.
0.006417	1.6	0.85	0.85	2.			
2006.	0.	151.	1.0	0.003	0.	0.10	0.
0.001917	2.0	0.94	0.94	2.			
2892.	0.	217.	1.0	0.003	0.	0.10	0.
0.006417	1.6	0.85	0.85	2.			
5345.	0.	401.	1.0	0.003	0.	0.10	0.
0.006417	1.6	0.85	0.85	2.			
8645.	0.	652.	1.0	0.003	0.	0.10	0.

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LMI4
36.        0.        2.19      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
117.       0.        7.01      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
234.       0.        14.1      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
477.       0.        28.5      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
803.       0.        48.7      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
1303.      0.        79.5      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
2067.      0.        124.      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
2981.      0.        179.      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
5508.      0.        331.      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
8961.      0.        538.      1.0       -0.035    0.        0.10      0.
0.001917   2.0       0.94      0.94      2.
21.        0.        1.58      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
67.        0.        5.05      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
135.       0.        10.1      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
275.       0.        20.6      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
464.       0.        34.8      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
654.       0.        56.6      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
1193.      0.        89.5      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
1720.      0.        129.      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
3179.      0.        238.      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
5170.      0.        388.      1.0       0.003     0.        0.10      0.
0.006417   1.6       0.85      0.85      2.
LHAND
.4656      .3729     .0746     .0469     .0249     .0076     .0038     .0014
.0010      .0103
.0053      .3465     .4079     .1505     .0618     .0158     .0069     .0028
.0012      .0107
.0016      .0055     .3019     .4546     .1143     .0675     .0279     .0160
.0035      .0722
.0011      .0026     .0124     .4971     .2235     .1314     .0522     .0495
.0287      .0345
.0010      .0014     .0020     .1147     .5257     .2909     .0401     .0107
.0077      .0048
.0005      .0011     .0042     .0105     .2233     .6151     .1093     .0186
.0059      .0055
.0035      .0016     .0050     .0061     .0183     .6931     .2083     .0371
.0138      .0192
.0002      .0006     .0010     .0030     .0040     .3104     .5045     .1260
.0312      .0191
.0001      .0002     .0019     .0028     .0036     .0057     .0762     .3201
.5537      .0107
.0001      .0002     .0002     .0006     .0039     .0016     .0019     .0027
.2474      .7444
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.4771	.3338	.0479	.0670	.0326	.0152	.0079	.0036
.0031	.0314						
.0132	.2547	.3358	.1996	.1036	.0536	.0222	.0106
.0034	.0023						
.0042	.0150	.1857	.4437	.1658	.0843	.0602	.0198
.0108	.0015						
.0020	.0366	.0128	.3768	.3175	.2097	.0461	.0169
.0054	.0030						
.0004	.0051	.0124	.0657	.4046	.3051	.1536	.0322
.0166	.0033						
.0003	.0014	.0046	.0056	.2074	.5998	.1449	.0224
.0102	.0014						
.0009	.0017	.0032	.0071	.0237	.5153	.3408	.0941
.0032	.0040						
.0005	.0010	.0053	.0059	.0056	.2318	.4692	.2180
.0400	.0217						
.0004	.0192	.0014	.0035	.0041	.0097	.0513	.3471
.5558	.0258						
.0001	.0001	.0003	.0006	.0007	.0009	.0014	.0021
.3892	.5956						
.1375	.2049	.2237	.1936	.1046	.0947	.0271	.0095
.0041	.0003						
.0193	.1157	.2403	.1974	.1603	.1448	.0853	.0283
.0080	.0006						
.0047	.0217	.1959	.3885	.1553	.1314	.0719	.0226
.0054	.0006						
.0022	.0079	.0445	.1913	.2387	.2749	.1931	.0289
.0146	.0039						
.0003	.0027	.0108	.0500	.3198	.4521	.1198	.0231
.0135	.0027						
.0003	.0036	.0109	.0133	.1659	.5849	.1377	.0528
.0284	.0042						
.0002	.0016	.0094	.0166	.1196	.2165	.3473	.1738
.1052	.0098						
.0001	.0014	.0047	.0072	.0093	.1045	.3752	.2891
.1951	.0124						
.0001	.0095	.0024	.0043	.0052	.0101	.0370	.2168
.7025	.0201						
.0001	.0001	.0003	.0006	.0038	.0015	.0022	.0029
.2233	.7712						
LHA2							
.9000	.6290	.2300	.0500	.0050	.0050	.0050	.0050
.0050	.0350						
.1000	.3490	.7700	.9500	.9950	.9950	.9950	.9950
.9950	.9350						
.9800	.4000	.5600	.2500	.0800	.0300	.0200	.0200
.0200	.0999						
.0200	.2000	.4400	.7500	.9200	.9700	.9800	.9800
.9800	.9710						
.9730	.6430	.6900	.4400	.2500	.1500	.0700	.0500
.0350	.0790						
.0300	.1500	.3100	.5600	.7500	.8500	.9300	.9500
.9650	.9190						
ABFCT							
1.63	1.62	1.60	1.58	1.57	1.55	1.54	1.52
1.47	1.39						
1.85	1.34	1.81	1.78	1.76	1.73	1.71	1.66
1.54	1.42						
2.65	2.56	2.41	2.25	2.11	2.00	1.91	1.76
1.56	1.44						
LHDOST							
76.	163.	250.	375.	500.	750.	1000.	3000.
LH48V0							

```
76.       3000.     50.       3000.
LHSVDS
50.       175.      375.      750.      1750.
AIRDST
25.       50.       100.      150.      200.      250.      300.      500.
1000.     3000.
EMPL
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
519.66    259.83    0.        1.0       -0.07     -0.01     0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
628.53    314.20    0.        1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
EMTC
1210.     605.      21.89     1.0       -0.035    -0.005    0.10      0.
0.003583  1.35      0.91      0.91      2.
1290.     645.      22.78     1.0       -0.0175   -0.0025   0.10      0.
0.003583  1.35      0.91      0.91      2.
1384.     691.      23.82     1.0       -0.007    -0.001    0.10      0.
0.003583  1.35      0.91      0.91      2.
1441.     721.      26.86     1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
1453.     726.      27.03     1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
1444.     722.      26.92     1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
1466.     733.      33.23     1.0       0.00      0.00      0.10      0.
0.003583  1.35      0.91      0.91      2.
1514.     757.      33.26     1.0       0.00      0.00      0.10      0.
```

0.003583	1.35	0.91	0.91	2.			
1635.	813.	34.80	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
2019.	1010.	38.38	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
FMT3							
1210.	605.	21.59	1.0	-0.035	-0.005	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1293.	545.	22.78	1.0	-0.0175	-0.0025	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1384.	691.	23.82	1.0	-0.007	-0.001	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1411.	721.	26.86	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1453.	725.	27.33	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1444.	722.	26.32	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1465.	733.	33.23	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1514.	757.	33.26	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1635.	813.	34.80	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
2019.	1010.	38.88	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
EMM							
0.149	0.074	0.019	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.158	0.079	0.021	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.156	0.083	0.022	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.173	0.086	0.023	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.175	0.0087	0.023	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.173	0.086	0.023	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.177	0.088	0.023	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.184	0.092	0.024	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.198	0.099	0.026	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.250	0.124	0.033	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.152	0.076	0.020	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.159	0.079	0.021	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.158	0.084	0.022	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.173	0.086	0.023	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.175	0.087	0.023	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.173	0.096	0.023	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.177	0.098	0.023	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.182	0.091	0.023	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			

0.136	[illegible]	0.026	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.244	0.122	0.032	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
EMOW							
5740.	2869.	63.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6081.	3040.	66.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6423.	3211.	70.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
66696.	3349.	73.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6765.	3382.	74.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6695.	3349.	73.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6833.	3416.	75.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
7106.	3553.	78.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
7653.	3826.	84.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
9635.	4817.	105.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
5875.	2938.	64.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6150.	3074.	67.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6491.	3245.	71.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6696.	3349.	73.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6765.	3342.	74.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6696.	3348.	73.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6833.	3416.	76.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
7035.	3518.	77.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
7585.	3792.	83.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
9430.	4714.	103.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
EMIW							
4071.	2035.	44.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4314.	2156.	47.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4555.	2278.	50.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4750.	2375.	52.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4799.	2399.	52.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4750.	2375.	52.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4847.	2423.	53.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
5041.	2520.	55.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
5429.	2714.	59.	1.0	-0.07	-0.01	0.10	0.

0.003583	1.35	0.91	0.91	2.			
6834.	3416.	75.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4158.	2034.	46.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4352.	2131.	48.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4605.	2302.	50.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4750.	2375.	52.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4799.	2399.	52.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4750.	2375.	52.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4847.	2423.	53.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
4992.	2496.	55.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
5380.	2690.	59.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
6684.	3344.	73.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
EMD							
1512.	0.	16.15	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	4.			
1494.	0.	15.84	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	4.			
1516.	0.	16.19	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	4.			
1924.	0.	20.54	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	4.			
5484.	0.	58.56	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	4.			
EMDL							
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
519.66	259.83	0.	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			

628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.15	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.15	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.15	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.15	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.15	0.91	0.91	2.			
628.53	314.20	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.15	0.91	0.91	2.			
EMVD							
877.	0.	6.33	1.0	0.05	0.	0.10	0.
0.003583	1.15	0.91	0.91	3.			
EM48							
5484.	0.	54.56	1.0	0.06	0.	0.10	0.
0.003583	1.15	0.82	0.42	3.			
EMBND							
.7857	.2229	.0202	.0116	.0050	.0023	.0006	.0004
.0002	.0001						
.0158	.5135	.3703	.0706	.0198	.0066	.0019	.0003
.0031	.0001						
.0107	.0167	.4487	.4210	.0623	.0240	.0083	.0045
.0031	.0007						
.0079	.0395	.0197	.6616	.1879	.0790	.0188	.0116
.0030	.0010						
.0049	.0066	.0171	.1638	.5599	.2218	.0175	.0056
.0027	.0001						
.0026	.0044	.0055	.0151	.2998	.5845	.0688	.0113
.0051	.0019						
.0024	.0056	.0084	.0097	.0350	.7570	.1262	.0409
.0118	.0030						
.0018	.0023	.0038	.0049	.0056	.4122	.4752	.0815
.0033	.0044						
.0010	.0317	.0025	.0047	.0052	.0213	.1101	.3719
.4673	.0143						
.0001	.0002	.0002	.0006	.0011	.0018	.0025	.0040
.3545	.6350						
.7442	.1952	.0339	.0155	.0046	.0038	.0012	.0008
.0005	.0003						
.0473	.4351	.3523	.1065	.0336	.0172	.0047	.0013
.0037	.0001						
.0247	.0481	.3159	.4577	.0954	.0358	.0155	.0040
.0017	.0002						
.0164	.0217	.0260	.4948	.2918	.1261	.0164	.0055
.0014	.0004						
.0090	.0243	.0319	.0710	.5155	.2556	.0697	.0163
.0054	.0013						
.0019	.0072	.0031	.0101	.2909	.5731	.0945	.0088
.0029	.0015						
.0096	.0173	.0257	.0335	.0488	.5572	.2481	.0559
.0029	.0019						
.0148	.0153	.0182	.0214	.0252	.3108	.4172	.1440
.0280	.0341						
.0072	.0093	.0109	.0136	.0182	.0227	.0772	.4025
.4340	.0044						
.0026	.0331	.0042	.0058	.0051	.0088	.0117	.0216
.4335	.5026						
.4575	.2465	.1555	.0942	.0217	.0172	.0044	.0017
.0012	.0001						
.0955	.2794	.3458	.1502	.0612	.0431	.0179	.0044
.0024	.0003						

.0323	.0651	.3046	.4163	.0947	.0557	.0171	.0026
.0013	.0001						
.0237	.0116	.0457	.2794	.2501	.2281	.0741	.0206
.0051	.0002						
.0014	.0152	.0331	.0927	.3926	.3977	.0595	.0068
.0031	.0307						
.0012	.0037	.0116	.0502	.1992	.5122	.0902	.0183
.0115	.0117						
.0014	.0056	.0112	.0197	.0622	.3365	.4308	.1064
.0231	.0031						
.0007	.0026	.0049	.0103	.0211	.1615	.4463	.2358
.0974	.0194						
.0036	.0312	.0023	.0041	.0089	.0172	.0585	.2639
.6019	.0414						
.0031	.0301	.0003	.0006	.0010	.0013	.0029	.0044
.3010	.6431						
FMA2							
.1210	.0572	.0520	.0308	.0241	.0269	.0323	.0379
.0528	.0753						
.0909	.0539	.0194	.0116	.0066	.0047	.0030	.0022
.0016	.0304						
.1271	.0734	.0426	.0308	.0236	.0202	.0262	.0348
.0551	.0477						
.1310	.0537	.0237	.0123	.0069	.0027	.0018	.0014
.0012	.0007						
.1050	.0750	.0500	.0259	.0179	.0177	.0190	.0210
.0250	.0323						
.1020	.0740	.0320	.0120	.0057	.0020	.0019	.0017
.0012	.0004						
IMPL							
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
487.67	243.84	0.	1.0	-.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.

0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
672.79	336.39	0.	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
IMTC							
476.	238.	13.47	1.0	-0.035	-0.005	0.10	0.
0.003583	1.35	0.91	0.91	2.			
501.	250.	14.12	1.0	-0.0175	-0.0025	0.10	0.
0.003583	1.35	0.91	0.91	2.			
517.	258.	14.33	1.0	-0.007	-0.001	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	16.86	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	16.87	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	16.91	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	22.98	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	22.53	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	22.72	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	22.55	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
IMTD							
476.	238.	13.87	1.0	-0.035	-0.005	0.10	0.
0.003583	1.35	0.91	0.91	2.			
501.	250.	14.12	1.0	-0.0175	-0.0025	0.10	0.
0.003583	1.35	0.91	0.91	2.			
517.	258.	14.33	1.0	-0.007	-0.001	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	16.86	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	16.87	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	16.91	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	22.98	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	22.53	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	22.72	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
527.	263.	22.55	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
IMM							
0.0261	0.0131	0.0034	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0277	0.0139	0.0036	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0292	0.0147	0.0038	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0305	0.0153	0.0040	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0308	0.0154	0.0040	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0305	0.0153	0.0040	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0311	0.0156	0.0041	1.0	-0.07	-0.01	0.10	0.

0.043	1.35	0.91	0.91	2.			
0.0323	0.0162	0.0042	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0349	0.0175	0.0046	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0439	0.0220	0.0057	1.0	-0.07	-0.01	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0267	0.0134	0.0035	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0280	0.0140	0.0037	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0295	0.0148	0.0039	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0305	0.0153	0.0040	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0308	0.0154	0.0040	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0305	0.0153	0.0040	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0311	0.0156	0.0041	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0320	0.0161	0.0042	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0345	0.0173	0.0045	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
0.0429	0.0215	0.0056	1.0	0.00	0.00	0.10	0.
0.043	1.35	0.91	0.91	2.			
IMOW							
1011.	505.	11.0	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1071.	535.	11.7	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1131.	565.	12.4	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1173.	587.	12.9	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1191.	595.	13.0	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1179.	589.	12.9	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1203.	601.	13.1	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1251.	625.	13.7	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1347.	673.	14.7	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1695.	847.	18.5	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1035.	517.	11.3	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1083.	544.	11.8	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1143.	571.	12.5	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1173.	587.	12.9	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1191.	595.	13.0	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1179.	589.	12.9	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1203.	601.	13.1	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1233.	617.	13.5	1.0	0.00	0.00	0.10	0.

0.003583	1.35	0.91	0.91	2.			
1335.	667.	14.5	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1660.	830.	18.1	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
IMIN							
717.	359.	7.8	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
759.	380.	8.3	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
802.	401.	8.8	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
835.	418.	9.1	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
844.	423.	9.2	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
836.	416.	9.1	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
853.	427.	9.3	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
887.	444.	9.7	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
955.	478.	10.4	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1203.	602.	13.1	1.0	-0.07	-0.01	0.10	0.
0.003583	1.35	0.91	0.91	2.			
734.	367.	8.0	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
768.	384.	8.4	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
810.	405.	8.9	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
835.	419.	9.1	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
844.	423.	9.2	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
835.	419.	9.1	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
853.	427.	9.3	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
879.	440.	9.6	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
947.	474.	10.3	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
1177.	589.	12.9	1.0	0.00	0.00	0.10	0.
0.003583	1.35	0.91	0.91	2.			
ITD							
1094.	0.	11.20	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
1248.	0.	16.98	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
1402.	0.	22.75	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
1624.	0.	31.05	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
1845.	0.	39.34	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
2283.	0.	55.94	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
2732.	0.	75.54	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
4063.	0.	122.33	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			

1537.	0.	14.06	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
1892.	0.	21.11	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
2243.	0.	27.84	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.92	0.82	0.			
2752.	0.	38.29	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
3259.	0.	48.42	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
4273.	0.	68.68	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
5287.	0.	88.40	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
8329.	0.	149.72	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
2485.	0.	20.13	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
3090.	0.	28.80	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
3695.	0.	37.47	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
4564.	0.	49.92	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
5433.	0.	62.38	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
7171.	0.	87.29	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
8910.	0.	112.20	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
14125.	0.	186.93	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
3605.	0.	27.58	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
5207.	0.	42.93	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
6808.	0.	58.29	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
9107.	0.	80.35	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
11410.	0.	102.42	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
16012.	0.	146.54	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
20613.	0.	19067.	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
34418.	0.	323.04	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
545000.	0.	3501.	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
713000.	0.	4576.	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
882000.	0.	5659.	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
1126000.	0.	7228.	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
1349000.	0.	8658.	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
1799000.	0.	11544.	1.0	0.06	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
2251000.	0.	14517.	1.0	0.05	0.	0.10	0.
0.003583	1.35	0.82	0.82	0.			
5843000.	0.	37544.	1.0	0.05	0.	0.10	0.

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0.003583  1.35     0.82     0.12     0.
IMOL
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
487.67    241.44   0.       1.0      -.07     -0.01    0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
672.79    336.39   0.       1.0      0.00     0.00     0.10     0.
0.003583  1.35     0.91     0.91     2.
IMAZ
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.0475     .0648
.0072     .0068    .0049    .0025    .0039    .0004    .0003    .0003
.0032     .0001
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.0423     .0455
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.0007     .0003
.0155     .0175    .0198    .0225    .0248    .0265    .0273    .0275
.0285     .0194
.0150     .0173    .0095    .0059    .0034    .0018    .0015    .0015
.0013     .0006
IMRND
.7367     .2229    .0202    .0116    .0050    .0023    .0006    .0004
.0032     .0001
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.0001     .0991
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.0031     .0007
.0079     .0335    .0197    .6616    .1879    .0790    .0188    .0116
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.0083	.3344						
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.4673	.0143						
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.0017	.0002						
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.0014	.0004						
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.0029	.0015						
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.0029	.0010						
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.4335	.5026						
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.0012	.0001						
.0355	.2734	.3458	.1502	.0612	.0431	.0179	.0044
.0024	.0093						
.0323	.0661	.3086	.4163	.0997	.0559	.0171	.0026
.0013	.0101						
.0237	.0316	.0857	.2798	.2501	.2281	.0741	.0206
.0051	.0002						
.0014	.0152	.0301	.0927	.3926	.3479	.0595	.0068
.0031	.0007						
.0012	.0037	.0116	.0502	.1992	.6122	.902	.0183
.0115	.0019						
.0014	.0956	.0112	.0197	.0622	.3365	.4308	.1064
.0231	.0031						
.0037	.0026	.0049	.0103	.0211	.1615	.4463	.2358
.0974	.0194						
.0006	.0012	.0023	.0041	.0089	.0172	.0585	.2639
.6019	.0414						
.0031	.0091	.0003	.0006	.0010	.0013	.0029	.0044
.3010	.6183						
TAXES							
0.01	0.01	0.07	0.005	0.01	0.00	0.1	0.01
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	
0.079	0.079	0.079	0.08	0.08	0.08	0.08	0.08
0.08	0.08	0.08	0.08	0.08	0.08	0.08	
0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.18
0.18	0.18	0.18	0.18	0.18	0.18	0.18	
0.45	0.46	0.46	0.46	0.45	0.46	0.46	0.46
0.45	0.46	0.45	0.46	0.45	0.46	0.46	

1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0	
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	
0.45	0.46	0.46	0.46	0.46	0.46	0.46	0.46
0.45	0.46	0.46	0.46	0.45	0.46	0.46	
NODEL							
20000.	4000.	226.	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	1.			
2500.	500.	28.25	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	1.			
0.0	3000.	28.25	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	1.			
300.	60.	3.39	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	1.			
300.	60.	3.39	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	1.			
NODEU							
50000.	10000.	565.	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	0.			
2500.	500.	28.25	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	0.			
0.0	3000.	28.25	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	0.			
0.0	15000.	28.25	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	0.			
300.	60.	3.39	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	0.			
300.	60.	3.39	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	0.			
300.	60.	3.39	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	0.			
300.	60.	3.39	1.	.02	.07	.1	.01187
0.0	0.0	.78	0.0	0.			
MCI							
2599.13	0.0	49.86951	1.	.003	0.	.1	.025
0.0	0.0	.9	0.	2.			
2599.13	0.0	49.86951	1.	.003	0.	.1	.025
0.0	0.0	.9	0.	2.			
6.708	0.0	.12871	1.	.003	0.	.1	.025
0.0	0.0	.9	0.	2.			
6.708	0.0	.12871	1.	.003	0.	.1	.025
0.0	0.0	.9	0.	2.			
.5	.5	.5	.5	.5	.5	.5	.5
.5	.5	.5	.5	.5	.5	.5	
.5	.5	.5	.5	.5	.5	.5	.5
.5	.5	.5	.5	.5	.5	.5	
SPCI							
1900.	0.0	20.82167	1.	.03	0.0	.1	.00695
0.0	0.0	.9	0.	1.			
1900.	0.0	20.82167	1.	.01	0.0	.1	.00695
0.0	0.0	.9	0.	1.			
1000.	0.0	18.92333	1.	.03	0.	.1	.00695
0.0	0.0	.9	0.	1.			
1000.	0.0	18.92333	1.	.03	0.	.1	.00695
0.0	0.0	.9	0.	1.			
13.34	0.0	.23667	1.	.03	0.	.1	.00695
0.0	0.0	.9	0.	1.			
13.34	0.0	.23667	1.	.03	0.	.1	.00695
0.0	0.0	.9	0.	1.			
.5	.5	.5	.5	.5	.5	.5	.5

```
.5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5          .5
.5          .5          .5          .5          .5          .5          .5
TESTEQ
.009333333
.100833333.011166665
8.6308333 9.65       8.6308333 11.1125    11.115     11.158333 17.233333 16.696666
16.9675   16.791165
WESTUN
3807.     0.         263.      1.0        0.1        0.         0.1        0.
0.134     1.15       0.52      0.52       1.
14112.    0.         1.436     1.0        0.1        0.         0.1        0.
0.086     1.4        0.6       0.6        1.
ZZZZZZ
```